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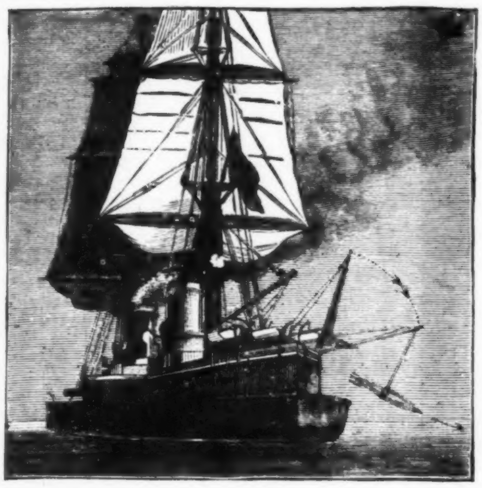
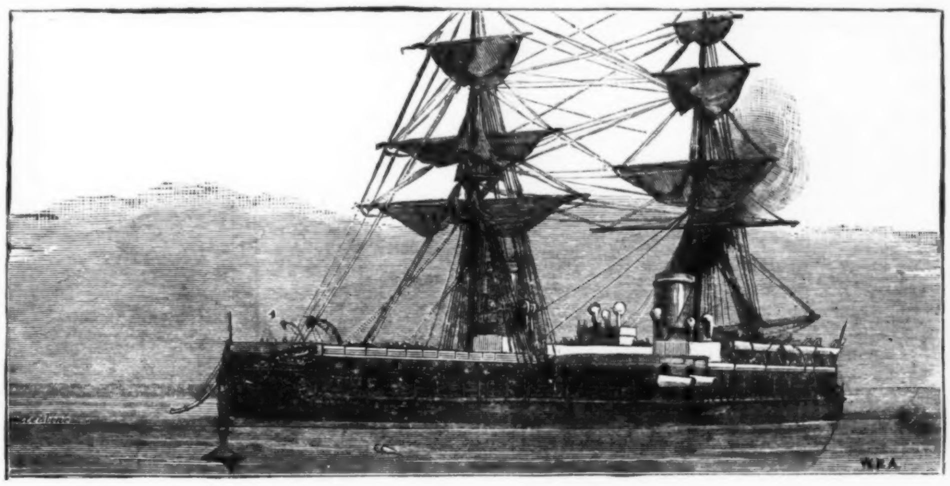
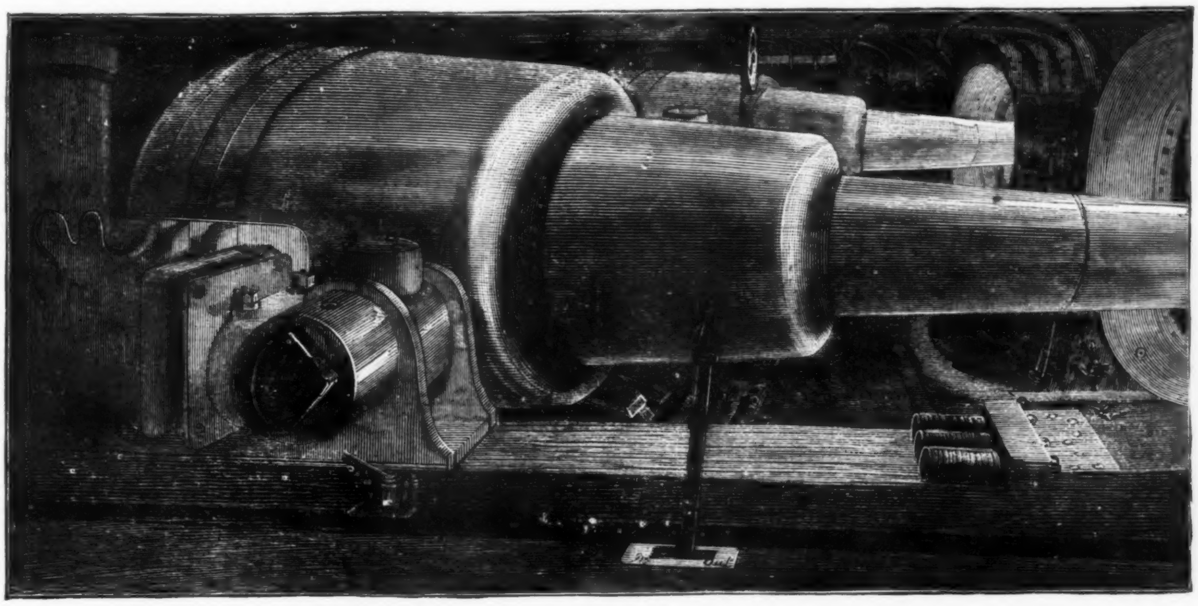


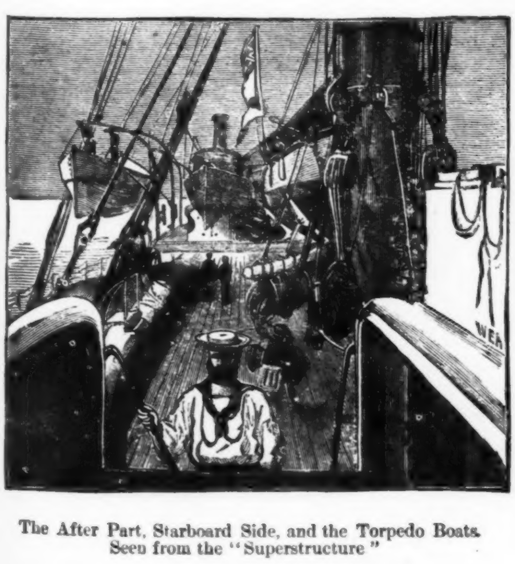
Stern View, Port Quarter, Showing Method of Launching the Whitehead Torpedo from the Superstructure.



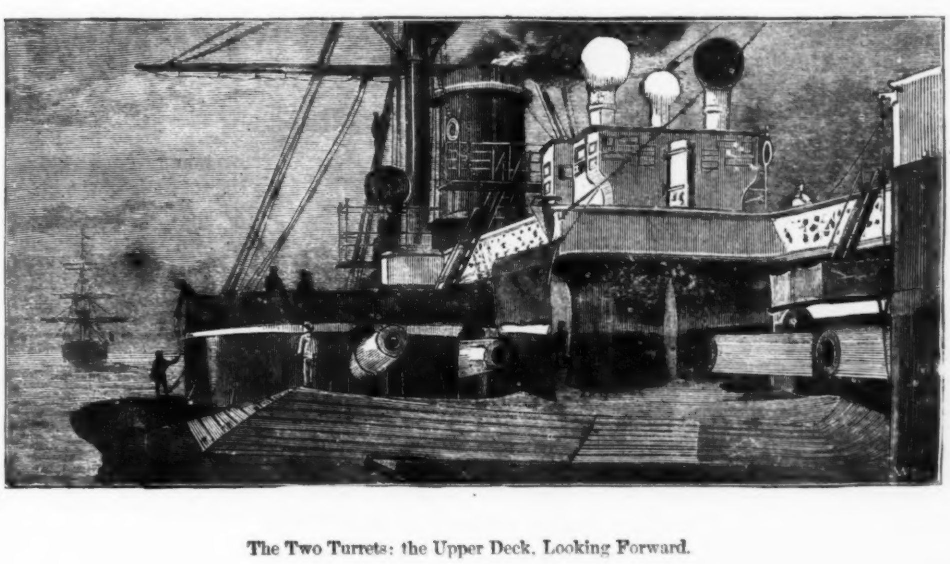
H.M.S. Inflexible from the Port Bow, Showing the Scoop for Launching the Torpedo: the Ram under Water, and the Submerged Torpedo Fired from the Side.



Inside the Turret: the 80-ton Guns Ready to be Run Out.



The After Part, Starboard Side, and the Torpedo Boats Seen from the "Superstructure"



The Two Turrets: the Upper Deck, Looking Forward.

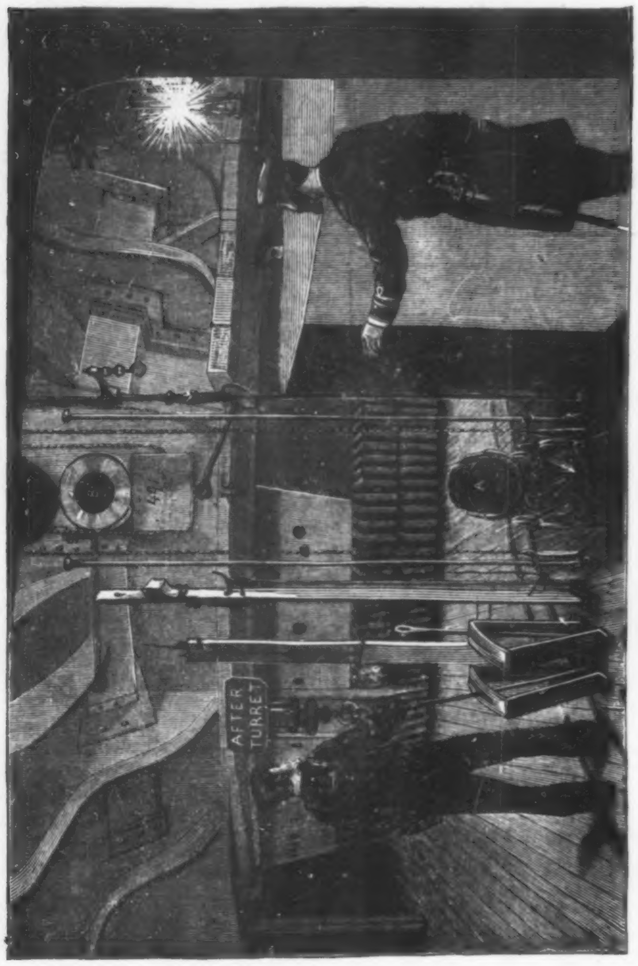
THE NEW WAR SHIP OF THE BRITISH NAVY—H.M.S. INFLEXIBLE.

H.M.S. INFLEXIBLE.

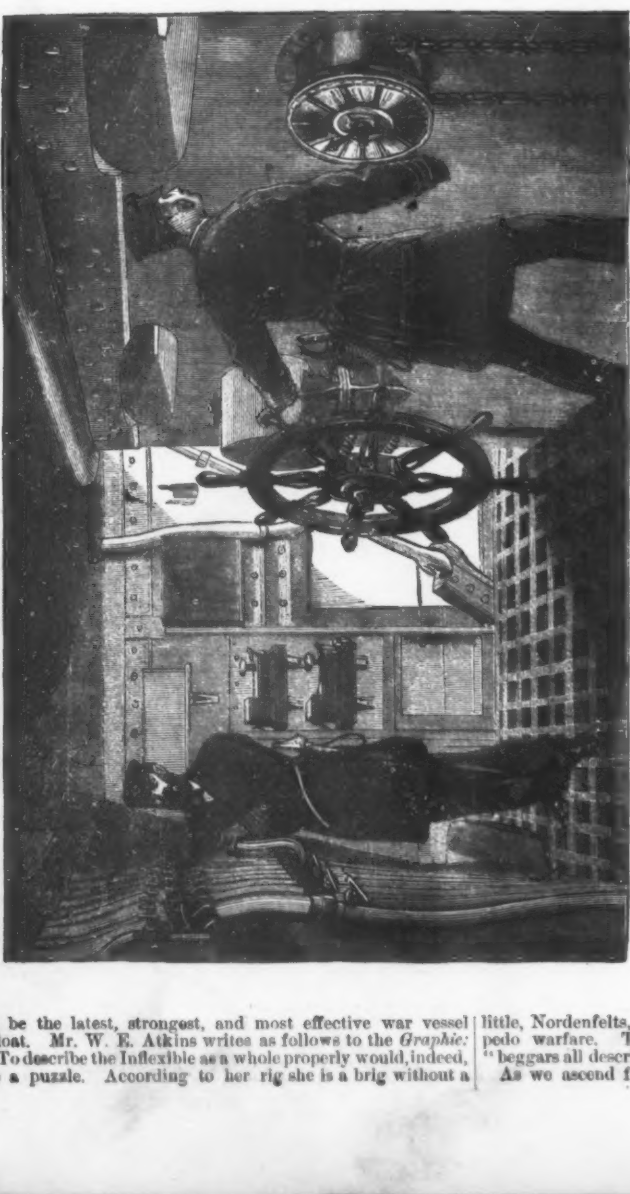
WE find in the London *Graphic* a number of illustrations, herewith given, of this remarkable ship, which is supposed to be the latest, strongest, and most effective war vessel afloat. Mr. W. E. Atkins writes as follows to the *Graphic:*

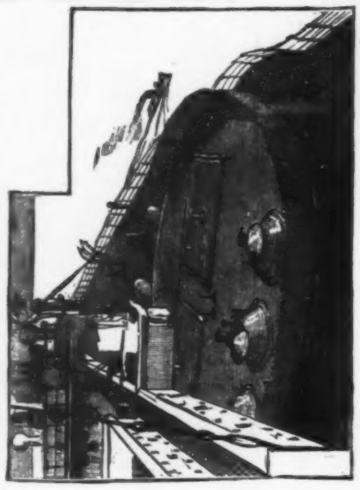
To describe the Inflexible as a whole properly would, indeed, be a puzzle. According to her rig she is a brig without a bowsprit; according to her dimensions, a long steam frigate with an immense beam; in other respects, she is a combination and a network of pneumatic tubes, steam pipes, engines, boilers, electric apparatus, etc., guns big, guns little, Nordenfelts, and all the latest appliances used in torpedo warfare. To sum up, she, like Cleopatra's barge, "beggars all description."

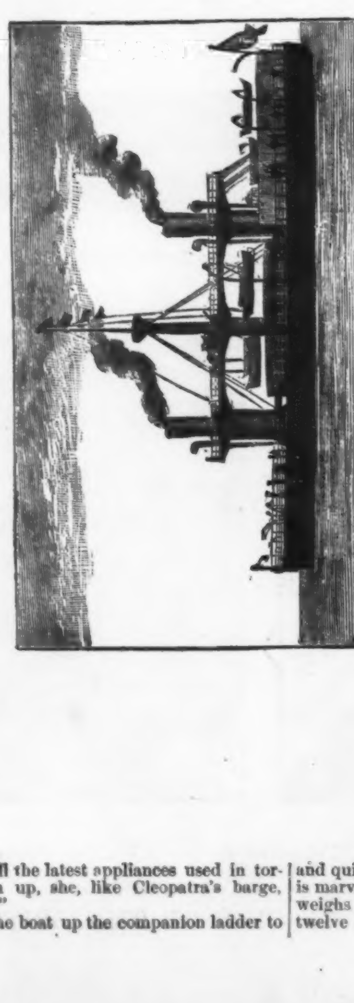
As we ascend from the boat up the companion ladder to the breastwork deck we stand on iron plates three inches in thickness, and before us rise the glacis plates in front of the turrets (Sketch No. 1), with their four 80-ton guns, whose muzzles are large enough to take in a boy of ten. The ease and quietness with which these massive structures are moved is marvelous, considering that each turret with its contents weighs 650 tons. The walls of the turrets are made up of twelve inches of steel-faced iron, with a backing of eleven

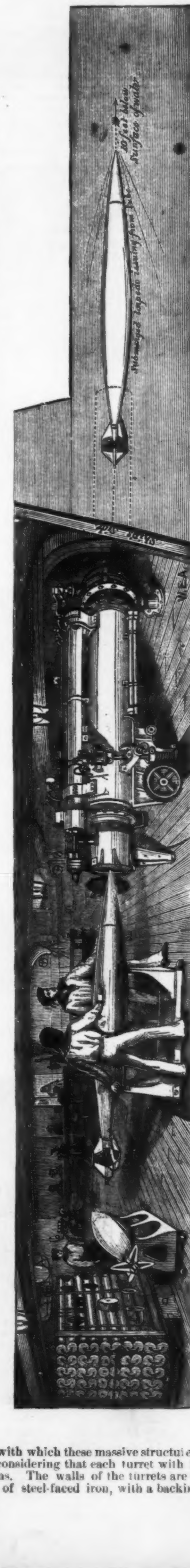


The Turret Below the Deck, Showing the Method of Loading the Guns.


The "Conning" Tower (Forward) Containing the "Armor Cross."

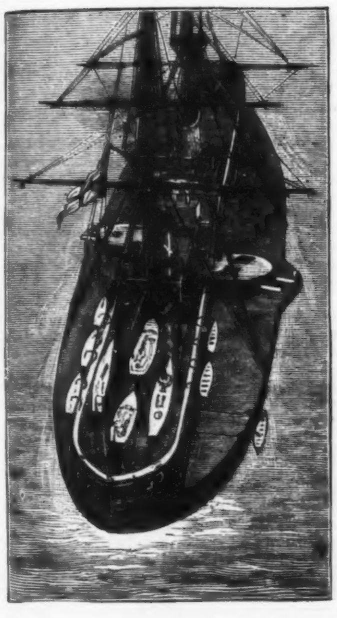

Looking over the Turret from the Fore Bridge: Sighting the Guns from the Manholes in the Turret.


The Italian Ship Duilio.

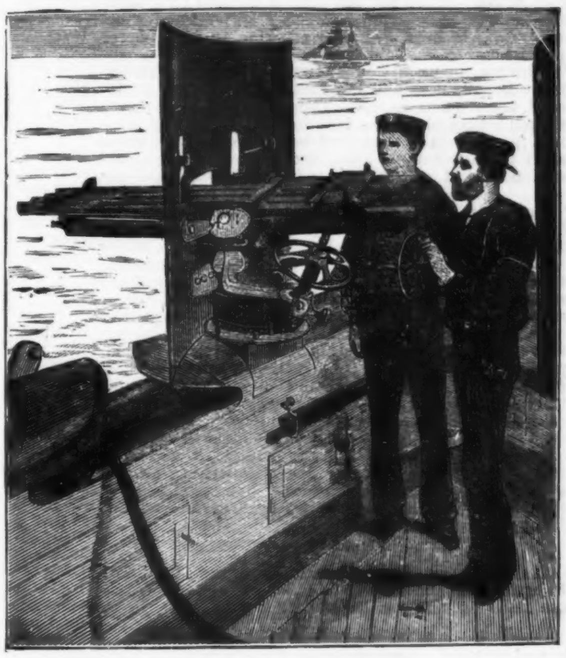

The Torpedo Room: Placing a "Whitehead" in the Pneumatic Tube (9 Feet Under Water) for Launching.

THE NEW WAR SHIP OF THE BRITISH NAVY—H.M.S. INFLEXIBLE.

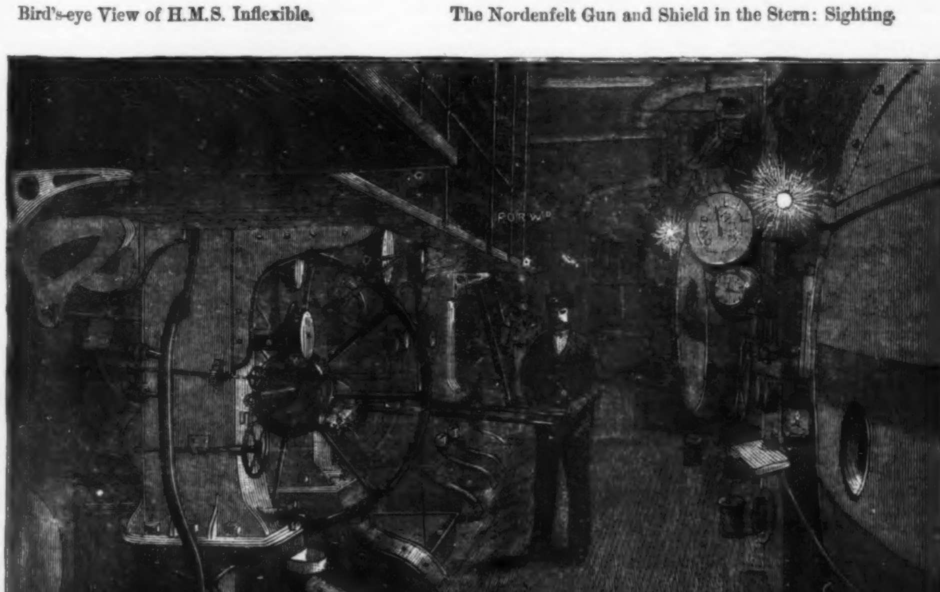
The Captain's Cabin.



Bird's-eye View of H.M.S. Inflexible.



The Nordenfelt Gun and Shield in the Stern: Sighting.



The Engine Room and Stoke Hole.

THE NEW WAR SHIP OF THE BRITISH NAVY—H.M.S. INFLEXIBLE.

inches of teakwood, then another twelve inches of iron, also backed with teak, with an inner skin of two inches of iron. When firing takes place there are inside each turret five men, besides officers; two men are stationed on the wall side of each gun, and the remainder at the breech. When loading, the turret is moved round until the lower part of the port hole is hidden under the deck glacis plates, the muzzle of the gun is depressed, and presents itself at an aperture below the deck. A small trolly conveys the powder and shot, A, along rails leading from the magazine until it stands immediately under and in front of the gun's mouth, B. Nothing now remains but to thrust the charge home, which operation is performed by a ramrod worked by steam power. The turrets, engines, magazines, and those parts which require protection are within what is named the citadel, a rectangular inclosure, 110 feet long by 75 feet broad, the sides of which are plated with 24 inches of iron, and are considered to be safe against the most powerful weapon yet invented.

As stated above, the deck over the citadel is three inches in thickness, the other parts on the same surface measure but half an inch. In going into action the captain and another officer are stationed in the foremost "conning" tower, standing on top of the superstructure, and within is the "armor cross," which is composed of two upright iron plates, twelve inches thick, intersecting each other at right angles; the longest plate is ten feet, and placed athwartships. In one or other of the four angles forming the cross stands the captain, and what is most interesting, he can there steer the ship, revolve the turrets, fire the big guns, and discharge the submerged torpedoes, either by turning a small wheel or simply touching an electric button; on the other hand, he can communicate by speaking through the voice tubes with his officers in any part of the ship below. In each angle of the cross the appliances are precisely the same and work together, so that if the officer in command finds himself exposed to the enemy's fire, he can protect himself by shifting to another angle. The horizon is "conned" through small embrasures in the cross in line with the eye. Descending to the turret deck, and after clambering over greasy iron work and farther going below on slippery iron ladders midst the stifling heat, the din of the engines, the hissing steam, and the spluttering uncertain electric lights, one finds himself in that most uncomfortable quarter, the stokehole and engine-room. This place, bad as it is, would be unbearable but for the draught of air from above which is constantly being pumped through the compartments.

Reckoning the pneumatic tubes with the ordinary engines, there are in all fifty-four. The consumption of coal is necessarily very great, and should the ship be "forced," in other words, go at full speed, she would burn all her fuel (1,200 tons) in six days, but with economical use the same amount would last over seventeen days. The sailing power of the Inflexible is not reckoned much, and it is doubtful if, under canvas, she would prove what nautical people call a "handy craft," excepting before the wind. In action all the gear but the lower masts would be cleared away, leaving the vessel entirely dependent on her engines, and should she be in danger of falling into an enemy's hands, by opening all the valves and the watertight compartment doors (there are 485 of the latter), she could be scuttled and sunk in eighteen minutes, or with the addition of the torpedo holes on the main-deck being open the time would be reduced to fourteen minutes. The pumping-power is very great, and if manual labor be added to the steam-power, 5,000 tons of water could be thrown overboard per hour. The hulls of the Inflexible and the Italian ships Dandolo and Duilio are nearly alike, but the two latter carry no masts, and their weight each is 800 tons less than that of the Inflexible, whose tonnage is 11,400. The Italian ships carry 100-ton guns against our 80-tons, but the turrets, although about the same thickness, are considered weaker, being composed of but one plate with its wood backing against our "compound" plates.

The armament of the Inflexible is not all above deck, for in the bow under water is the huge steel prow, while on either side, and ten feet below the surface of the water, is a torpedo-hole, through which a "Whitehead" could be shot. The room where these fish torpedoes are kept and launched from contains two large tubes or cylinders, which open at the end. The torpedo is wheeled along and placed within the tube, the door is then closed, and a pneumatic pipe, with a piston rod inside, is connected, which forces the torpedo at an immense velocity through the water by means of the compressed air stored within bundles of pipes. The compartments below are lit with oil lamps and electric lights, mostly on the "Brush" system, a few being "Gramme."

The captain's cabin is situated within the superstructure at the stern of the ship—a most cosy-looking spot, and tastefully decorated with painted flowers, etc., on each panel, executed by Miss Fisher, the Captain's daughter.

The appointment of Captain Fisher is admitted by every one to be a most happy choice. No one in the navy is more competent than he to understand the working of the various torpedo appliances, he having been in the school on board the Vernon from the first establishment of that branch of the service, now a most important one.

The Inflexible will be protected at her weak points under water by wire nets extending from the sides, while the Nordenfelts, Gatlings, and other small guns are of themselves considered quite sufficient to keep at distance any number of the enemy's torpedo boats. The Nordenfelt guns are stationed at the stern, and on the bridge over the turrets, and require two men to handle each gun. One man stands behind the breech to point and direct; the second man standing at the side working the lever for firing.

Either one or four shots can be fired at a time. The loading is from the top, the ammunition being supplied from a box (the hopper) fastened over the barrels, and containing forty rounds.

In the sketch the hopper is removed. A novelty is introduced by a system of launching Whitehead torpedoes over the superstructure; an iron tripod is fixed to the bulwarks, to the third leg of which is slung the torpedo, and at a given signal the leg is swung out, at the same time the torpedo escapes automatically, and propels itself through the water at the given depth to which it may be set.

There is an invention of Mr. Froude's to be tried when under way: it consists of a compartment below the water, the floor of which is twenty feet above the keel, stretching right across the vessel, and about amidships; this room is called the Water Space. Sixty tons of water are to be pumped in (not filling the space, half being water, and the remainder a vacuum), and it is urged that the ship will roll quicker than the body of water in the compartment, which will at first act as a counterpoise, and in the second place, as the ship rights herself, act as a buffer to prevent too much roll on the other side. The officers do not look with much favor on this innovation, conjecturing that the great rush is likely to injure if not burst the bulkheads, besides being a most unpleasant and a most noisy neighbor, being next the ward room and sleeping cabins. Very few ships have produced so much interest and curiosity as this costly experiment. Her length over all is 320 feet, and the broadest beam 75 feet.

The Inflexible has been on her sea trials. For the first she started from Plymouth (October 25, 1881), for Gibraltar, across the Bay of Biscay, where she behaved admirably, the oscillations being ten per minute, and the rolling but ten degrees, the sea at the time washing over the turrets. On the second occasion (in the Mediterranean), she was put through a much more severe ordeal, the rolling being faster and deeper, reaching seventeen degrees on one way, and fifteen on the other. In this cruise her sailing power was tested, when she was found not able to "stay" or go about easily. But it should be mentioned that the Inflexible was never originally intended by the designer to be fitted with either sail or mast.

On the last trial, the third, the vessel again behaved well, and, if we except her sailing power, there can be no doubt of the success of H.M.S. Inflexible.

THE ECONOMY OF GAS-ENGINES.*

By PROFESSOR W. E. AYRTON, F.R.S.

"As long as the lighting of our large cities was performed by gas, the cheap manufacture of illuminating gas was the important question; but now that electric lighting bids fair to displace other systems, the consideration that specially interests us is, not the extraction of illuminating gas from coal, but the employment of the store of energy in the latter to set in rapid rotation dynamo electric machines for producing the electric current used in lighting. In all our heat engines, however—be they steam, hot-air, or gas-engines—the energy of the coal is first converted into heat and then into mechanical motion; hence it is the economic extraction of heat from coal, together with its efficient employment, that is the foundation of commercial electric lighting."

After noticing the extravagance in working of the most modern style of steam engines (even of large size), consequent on the necessity of using the steam at a comparatively low temperature, he quotes the formula of Sadi Carnot for ascertaining the ratio of the heat converted into work to the total amount of heat contained in the steam (that is, the efficiency of the engine). This is $\frac{S - T}{S + 273}$; where S is the temperature of the steam (in degrees Centigrade) at the time of entering the cylinder, and T the temperature of the steam after condensation. From this, Professor Ayrton contends that a theoretically perfect engine would only use two-tenths of the total heat; while a good engine of large size only develops half this quantity. The lecturer dismissed with short consideration the claims of hot-air engines, consequent on the extreme difficulty that exists with them in preventing the air vessels being injured by heat; and then states his conviction that "the only other motor suitable for electrical purposes (apart from machines driven by water or wind power) is the gas engine." He proceeds:

"In applying the formula $\frac{S - T}{S + 273}$ to determine what the actual efficiency of a gas engine would be if there were no loss of heat by conduction, radiation, and convection, S must be taken as the mean temperature of explosion, which may be assumed to be about 2,500° C., and which corresponds with the temperature of only about 180° C. (the temperature of the steam at the commencement of the stroke in an ordinary condensing engine); while T, the temperature at which the products of combustion leave the engine, is about 300° C., as compared with about 60° C. in the condensing steam engine. Hence, with the present temperatures employed, the efficiency of a gas engine might be raised to about $\frac{2{,}500 - 300}{2{,}500 + 273}$, or about 75 per cent., if loss of heat by conduction, radiation, and convection, as well as friction, could be prevented; while in a condensing steam engine the greatest efficiency that could be obtained with the present temperatures employed could never exceed about $\frac{180 - 60}{180 + 273}$ or 20 per cent. It may be observed, that in consequence of the very high temperature of the exploded gas compared with the other temperatures, we only diminish the efficiency to 56 per cent., even if we suppose that the exploded gas had a temperature of only 1,750° instead of 2,500°, and that the gas after explosion had a temperature as high as 600° instead of 300; for $\frac{1{,}750° - 600}{1{,}750° + 273} = 0{\cdot}56$. In addition to this high theoretical efficiency of the gas engine, following directly from the laws of thermo-dynamics, the absence of a boiler furnace and chimney diminishes the practical loss of heat by conduction, radiation, and convection.

"We have shown, then, that practically a gas engine admits of being worked with much greater *efficiency* than either a steam engine or a hot-air engine—that is to say, the percentage of heat the former turns into mechanical work is much greater than with the latter two. We have now, however, to consider the *economy* of working, which depends also on the relative price of the fuel employed, and other items of working cost.

"To consider this in detail for a hot-air engine is hardly necessary, as this form of engine on a large scale has not been worked successfully; but in the accompanying Tables I. and II. will be found the comparative estimate of the working cost of a steam engine of the portable type, and of an 'Otto' gas engine, both indicating 30-horse power, for 300 days of 9 hours each. In this estimate the cost of the coal gas has been taken at 3s. per 1,000 cubic feet. Now, from these tables, it will be seen that, in spite of the very great relative efficiency of the gas engine, the cost of working with ordinary coal gas, at much less than the usual price, is greater than in the case of the steam engine, even when due allowance has been made, as you see, for the waste of fuel in getting up steam, and the waste of fuel after the engine has been stopped. Ordinary coal gas, however, is prepared for producing not heat, but light, and is, therefore, elaborately purified at a considerable cost, so that when it is used in a gas engine, it is used for a purpose quite different from that for which it was intended, and therefore we must not be surprised to find that the expense of working gas engines with illuminating gas is not so low as the mere calculation of the efficiency of the gas engine might have led us to anticipate."

Professor Ayrton contends that the positions would be reversed, and gas engines be the more economical, "if it be possible to manufacture for their use a cheap heating gas," as these small engines driven by such gas would not only "greatly surpass in economy steam engines of the same size, but produce energy at a cheaper rate per horse power than the largest steam engines ever made." As a step in the required direction, he instances the gas generator invented by Mr. J. Emerson Dowson, described in SCIENTIFIC AMERICAN SUPPLEMENT, No. 305. After giving a general description of the apparatus, the lecturer experimented with the gas in a eudiometer tube, and found that about 50 per cent. only of the Dowson gas is combustible. Its calorific power, or the number of heat units produced by the combustion of a cubic meter, is 1,538,358; and its calorific intensity, 2,268° C. To compare it with ordinary coal gas, he estimated the calorific power per cubic meter of the latter to be 5,590,399, and its calorific intensity as 2,554° C. Theoretically, therefore, the calorific power of coal gas is about 3½ times as great as that of the Dowson gas, but the latter, he asserts, is a gas which is not only suitable for any heating purpose, but can very well be used to drive a motor depending on explosions of gas. The comparative explosive force of the two gases, calculated in the usual way, is as 3·4 to 1—*i. e.*, coal gas has 3·4 times more energy than the Dowson gas. But because the combustion of carbon monoxide proceeds more slowly than that of carbureted hydrogen gases, and because the diluents present in the cylinder affect the weaker gas more than the coal gas, in practice (with an "Otto" engine) five volumes of the Dowson gas are used for one volume of coal gas.

Concluding his lecture, Professor Ayrton said: "In Table III. are given all the working expenses of an 'Otto' gas engine driven by the Dowson gas, and indicating 30-horse power for 300 days of 9 hours each. You will, therefore, be able to compare these expenses with those given in Tables I. and II. for the steam engine and the gas engine worked with coal gas. These figures show that a gas engine worked with Dowson gas costs about 45½ per cent. less than when worked with coal gas at so low a price as 3s. for 1,000 cubic feet, and about 47½ per cent. less than a steam engine of the portable type, after allowing in each case for repairs and depreciation and interest on capital outlay. The most striking feature, however, is that with a steam engine consuming 6 lb. of coal per indicated horse power per hour, and without adding an allowance for fuel used in getting up steam, and after work is done, 217 tons of coal are required to give the same power to 39 tons of coal converted into gas by the Dowson process. This represents a saving of about 88 per cent in the weight of fuel.

"Another practical consideration is that coal gas requires 220 to 250 lb. of coal per 1,000 cubic feet of gas, but the Dowson gas requires only 12 lb. per 1,000 cubic feet; and multiplying this by 5, to give the equivalent of 1,000 cubic feet of coal gas, we have 60 lb. instead of 220 to 250 lb. This is only 24 to 27 per cent. of the weight of the coal required for coal gas, and in many outlying districts this will effect an appreciable saving in the cost of transport.

"A further point of great interest is that a series of trials made with 3½ horse power (nominal) 'Otto' engines, driven by the Dowson gas, has proved that *one horse power (indicated) per hour is obtained with a consumption of gas derived from 1·46 lb. of coal*, after allowing 10 *per cent.* for impurities and waste of the latter.

"With gas engines of larger power the loss due to friction is proportionally less, and the consumption of gas per indicated horse power is less. Thus, with a 16 horse power (nominal) engine which can indicate up to about 40-horse power, the Dowson gas required would be about 90 cubic feet per horse power per hour, and this would give a consumption of coal of *only 1·2 per indicated horse power per hour.*

"The Tables I., II., and III. show the working expenses for engines giving 30 horse power, and this power is nearly sufficient for the 400 incandescent Swan lights which illuminate this hall at the present time. On the question, therefore, of motive power, after including the wages of the fireman, repairs, depreciation, and interest on capital outlay, etc., an 'Otto' engine worked with the Dowson gas can effect a saving of £125, compared with coal gas at 3s. per 1,000 cubic feet, and of £136 compared with a steam engine, supposing all to be working 2,700 hours per annum in lighting this Salle du Congrès with Swan lamps as at present.

"Moreover, with a cheap heating gas we can not only effect a saving in the motive power for electric lighting, but we can also use this gas for domestic and industrial purposes, such as cooking and heating. And for this there will be no need of a new system of piping under the streets, because the pipes which are now used to convey lighting gas can be used for heating gas only, when electric lights have superseded lighting gas."

TABLES SHOWING COMPARATIVE WORKING COST OF ENGINE, INDICATING 30 HORSE POWER, FOR 300 WORKING DAYS OF 9 HOURS EACH.

TABLE I.—*Steam Engine (Portable Type).*

The coal required = 6 per indicated horse power per hour, exclusive of coal burnt in getting up steam and after work is done. The following is the working cost: Coal = 30 × 6 × 2,700 = say 217 tons + allowance of 10 tons for coal consumed before and after work = 227 tons, at 15s.	£170	5	0
Water for engine, at 3 galls. per indicated horse power per hour = 3 × 30 × 2,700 = 243,000 + allowance for blowing off, etc., say 250,000, at 6d. per 1,000 gals.	6	5	0
Oil for engine, 3d. per day × 300	3	15	0
Wages of fireman, at 3s. 6d. × 300	52	10	0
Repairs and depreciation of boiler and engine (10 per cent. on £360)	36	0	0
Interest on capital outlay (5 per cent. on £360)	18	0	0
Total	£286	15	0

TABLE II.—*"Otto" Gas Engine Worked with Coal Gas.*

The consumption of gas for this sized engine = 18 cubic feet per indicated horse power per hour; therefore total gas required for 30 horse power for 2,700 hours = 30 × 18 × 2,700 = 1,458,000 cubic feet, at 3s. per 1,000 cubic feet	£218	14	0
Oil for engine, 4d. per day × 300	5	0	0
Wages for superintendence of engine, cleaning, etc., say 1s. per day × 300	15	0	0
Repairs and depreciation on engine (5 per cent. on £370)	18	10	0
Interest on capital outlay (5 per cent. on £370)	18	10	0
Total	£275	14	0

TABLE III.—*"Otto" Gas Engine Worked with Dowson Gas.*

With an "Otto" engine 5 volumes of Dowson gas give the same power as 1 volume of coal gas; therefore total Dowson gas required = 30 × 18 × 5 × 2,700 = 7,290,000 cubic feet. The following is the cost of working: Anthracite to make 7,290,000 cubic feet of gas (at 12 lb. per 1,000 cubic feet) including 10 per cent. for impurities and waste = 7,290 × 12 = say 39 tons, at 20s.	£39	0	0
Oil for engine, 4d. per day × 300	5	0	0
Wages for fireman, at 3s. 6d. × 300	52	10	0
Repairs and depreciation of engine (5 per cent. on £370) and of generator, holder, etc. (5 per cent. on £170)	27	0	0
Interest on capital outlay (5 per cent. on £540)	27	0	0
Total	£150	10	0

Economy in working cost in favor of Dowson gas compared with steam	47½ per cent.
Economy in working cost in favor of Dowson gas compared with coal gas, at 3s. per 1,000 cubic feet	45½ " "
Saving in weight of coal in favor of Dowson gas and gas engine, compared with steam engine requiring 6 lb. of coal per indicated horse power, is as 217 to 39 tons.	88 " "

* From a lecture delivered in French, on the 28th of September, in the Salle du Congrès at the Electrical Exhibition of Paris.

BESSEMER STEEL MANUFACTURE.*

ON THE USE OF A MECHANICAL AGITATOR IN THE MANUFACTURE OF BESSEMER STEEL.

By MR. W. D. ALLEN, Sheffield.

THE employment of Bessemer steel for many purposes for which the more expensive article, crucible steel, was at one time exclusively used, renders it necessary not only that each charge of the steel should contain a given and known amount of carbon, but also (and this is of paramount importance) that the carbon and manganese added to the converted metal at the end of the process should be diffused throughout the mass with the utmost regularity so as to insure the perfect homogeneity of every portion of the charge.

Every one who has witnessed the admixture of the highly carbureted spiegeleisen or ferro-manganese with wholly decarburized iron charged with oxygen, will have noticed the violent ebullition and disengagement of gas which accompanies the act of pouring these two dissimilar metals together, and will therefore readily understand how this disengagement of gas continues, though less violently, so long as any portion of these metals remains in an imperfect state of admixture. This is a condition which but too frequently continues during the pouring and solidification of the metal, thus giving rise to the violent ebullition seen in the moulds while casting, and consequently to unsound and bubbly ingots; in addition to which, veins or streaks of metal of different qualities and composition run in all directions through the mass, which though invisible to the eye, become palpably manifest in the physical properties of the steel when employed for delicate purposes.

A piece of imperfect glass furnishes a very good illustration of the steel in this condition; for upon examining the transparent mass, veins and striæ, arising from difference of density and composition, will be seen traversing in all directions. To the painter the want of uniform admixture in his colors is still more obvious. For example, in making a light gray color, if he adds to a white liquid paint about the same proportion of black color as the steelmaker adds of ferro-manganese to his charge of converted metal, he finds, by the most indisputable ocular demonstration, that, by the mere pouring of the two colors together after the manner of mixing practiced by the steelmaker, he utterly fails to produce a uniform gray tint in the liquid mass, to effect which he must diligently stir the mixed materials for a considerable time; and by so doing the marble-like veining, which is at first so clearly marked, becomes by degrees less and less conspicuous, until at last the whole mass presents a uniform tint of color. This is the condition of homogeneity to which the alloy of carbon and manganese with the converted metal must be brought if we desire to obtain a fluid which has ceased to throw off gas bubbles, and to obtain solid castings of a uniform quality throughout; and to this condition the steel can be brought by the aid of a powerful mechanical agitator, working out of contact with atmospheric oxygen. In the operation of steel melting in crucibles, it is found necessary not only to melt the metal, but to keep it in the molten condition some considerable time before pouring, in order to effect what is known by the term "killing it;" which, without doubt, means giving time for the carbon, manganese, etc., to well alloy and mix with the metal, and for the gases formed thereby to escape, which action slowly takes place, assisted doubtless by a slight circulation of the fluid metal in the pot. And this fact of the necessity of keeping the metal in a fluid state for some time, in order that its different constituents may become thoroughly incorporated, tends further to show the difficulty and uncertainty of insuring a thorough admixture of the materials in the Bessemer process by the means ordinarily practiced, particularly when we consider the large body of steel under operation, and the short space of time at command; and it clearly points to the agitator as our friend by whose assistance we can in a few seconds insure the perfect amalgamation and admixture so indispensably necessary.

This important fact appears to have forced itself on the attention of Sir Henry Bessemer as long ago as January, 1863, at which period he obtained a patent for various means of insuring a uniform or standard alloy, to be added to a precisely ascertained quantity of converted metal. In order to insure the perfect admixture and blending together of these materials, he devised a mechanical agitator revolving in the fluid metal beneath a covering of molten slag, and therefore out of contact with the atmosphere; and it does seem highly probable that had this method been adopted for the diffusion of the spiegeleisen in the earlier stages of the introduction of his process, much of that feeling of uncertainty in the material, and the general impression of want of uniformity, would never have arisen, and many of the fancy tests now imposed by consumers would not have come into fashion.

The constantly increasing demand for Bessemer steel of high and uniform quality caused the writer's attention to be directed to the attainment of that object; but notwithstanding the greatest care in the operation and in the selection of materials, the results obtained in practice seemed, from some occult and undefined cause, to vary occasionally to an extent that was perplexing and unsatisfactory. Continued attention to the subject, however, convinced him that the want of that coveted uniformity arose almost entirely from the want of perfect admixture of the carbon and manganese with the converted metal; for notwithstanding the natural tendency there seems to be for the molten spiegeleisen to diffuse itself, and also of the mixing action that does undoubtedly take place in running the charge first into the ladle and then into the moulds, analysis showed a want of perfect admixture, and the steel, though equal enough for rails, was not found so when used for many other purposes. To overcome these difficulties it was decided to make trial of the mechanical agitator above referred to, and one was constructed at the works of the Henry Bessemer Company, and put into operation about three years ago. The writer believes this to be the first and only application that has yet been made of it, and the object of the present paper is to bring under the notice of the Institute the fact of its perfect practicability, and to make known some of the advantages obtained by its use.

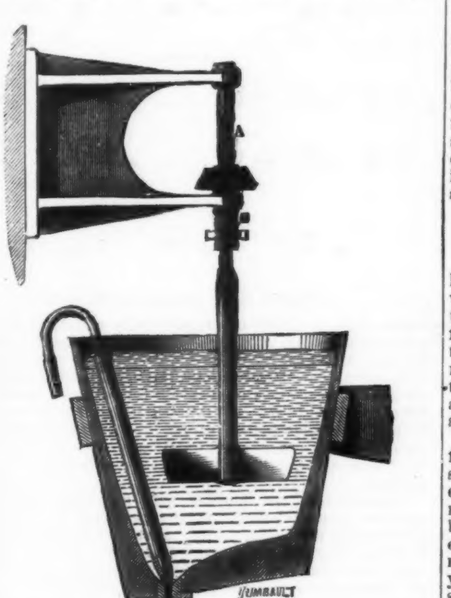
* Paper read before the Iron and Steel Institute.

The mixing or stirring operation takes place in the ladle immediately before casting, and the apparatus is shown on the diagram, and consists of a vertical spindle, A, having at its bottom end a socket, B. This spindle is supported in bearings, and is fixed at some convenient part of the pit where the ladle of steel can be brought by the ladle crane immediately beneath it. The spindle is driven by bevel wheels and a horizontal shaft, the shaft being sufficiently long to remove any driving appliance from the heat or any splashing that may take place. The agitator itself is simply an iron rod about 1½ in. in diameter, one end slightly tapered to fit easily into the socket, B, where it is held by a cotter, while the other end has a long slot punched in it, through which is inserted the blade or plate of iron, about 2 ft. long, 4 in. to 5 in. wide, and about ¾ in. thick. The blade, after insertion into the slot, is twisted at each end, so as to give it somewhat the form of a screw propeller blade. The rod and blade are coated over with loam or ganister, which has to be thoroughly dried, blacked, and carefully prepared. The taper end of the rod is then inserted into the socket, B, and cottered into its place ready for use. The ladle of steel, immediately it is turned out of the vessel, is brought beneath the agitator, and raised by the hydraulic crane, immersing the blade and a portion of the rod in the steel. Rotary motion of about one hundred turns per minute is then given to it, the ladle being lowered and raised again during the operation to insure all portions of the steel being operated upon. When the stirring is deemed sufficient, the ladle is lowered clear of the agitator, and the casting is proceeded with in the usual way.

Nothing could work more satisfactorily than this apparatus has done since the time of its erection. Occluded gases are expelled in large quantities by the operation, insuring an almost perfect degree of soundness and freedom from bubbles both in ingots and castings; the metal flowing into the moulds with a quietness supposed to be the exclusive characteristics of dead-melted crucible steel.

Every ingot formed from the largest charges is now found by analysis to be perfectly uniform in temper and quality, while the thoroughly homogeneous quality of every part of the same ingot is evinced by its behavior under the hammer or in the rolls, as well as in hardening and tempering.

The great extremes and varieties of temper now required also tend to render complete admixture more necessary than heretofore. It sometimes happens that, to obtain the required degree of hardness, as much as 14 cwt. to 15 cwt. of spiegeleisen must be added to the charge of 5 tons, and on other occasions not more than 84 lb. of ferro-manganese is employed for the same quantity of converted metal in order to retain the necessary degree of softness. In such extreme cases the necessity for thorough admixture must be obvious; for in the case of the large addition of spiegeleisen before referred to, a very little want of complete admixture would result in hard places being formed in the steel; and in case of the small addition of ferro-manganese, unless it was well diffused throughout the mass, some portion of the charge would not be workable.



The writer would here observe how small a quantity of ferro-manganese is capable of rendering good Bessemer steel beautifully ductile and malleable when it is thoroughly diffused. He has made charges of five tons with the addition of only 28 lb. of ferro-manganese (75 per cent. manganese), and when well stirred every ingot has hammered and worked beautifully.

Reference has hitherto chiefly been made to the use of the agitator in the manufacture of the higher classes of steel. Attention should, however, be drawn to its use in the manufacture of steel for boiler and ship plates, for in no case can perfect homogeneity be more important or unequal admixture be more destructive. For example, let us suppose an ingot in which, from imperfect admixture, there run some veins more or less parallel with each other, and that these so-called veins consist of portions of the metal still partaking to some extent of the soft and weak quality due to the absence of a proper amount of spiegeleisen, while other contiguous layers would in consequence be too highly carburized. Now, if such an ingot be rolled into a plate with these veins running parallel to its surface, no great loss in its resisting power would result; but if, on the contrary, these veins are at right angles to its surface (and such an ingot would be just as likely to be rolled in this way), they would be rolled into bands several inches or a foot apart; the strength of the plate to resist rupture would in that case depend upon the cohesive strength of the metal in these bands of soft and weaker material. And although we cannot suppose the case precisely as chosen by way of illustration, it will be sufficiently obvious that for all plates the most perfect homogeneity and the most thorough admixture of these widely different materials are absolutely necessary in order to develop the full ductility and cohesive strength of the plate.

It will be pretty generally known by users of the Bessemer process that the practice of turning up, or partially turning up, the vessel after adding the spiegeleisen is sometimes resorted to in order to secure a mixture, and it does, no doubt to some extent, effect that object, but it has serious disadvantages. It oxidizes some of the carbon and manganese contained in the spiegeleisen, and what is far more serious, it recharges the steel with a large quantity of oxygen, which, at this stage of the process, it is all-important should be got rid of as far as possible.

A more complete and reliable diffusion of the spiegeleisen is but one of the advantages obtained by the agitator. The liberation of occluded gases is a most important feature in its use. The evolution of gas is very manifest during the stirring process, particularly at its commencement, when gas is seen to force its way through the slag covering in large quantities, frequently with a considerable roar, and the ebullition of the steel is sometimes so violent as to cause the metal to rise over the sides of the ladle, and the stirring has to be moderated. The simple fact is, that the violent frothing so frequently seen in the moulds while casting is got rid of in the ladle by the aid of the agitator, and sound castings, free of all honeycombing and uniform throughout, are now made with perfect regularity and certainty by the Bessemer process.

The stirring operation is found to be very simple in practice, causing no delay or inconvenience of any kind, and costing almost *nil*.

This mixing process has been in constant use more than three years at the works of the Henry Bessemer Company, and every charge of steel made during that time has been stirred. In fact, in those works, the stirring operation is by all regarded as one of the most essential in connection with the process, and no charge of steel would now be looked upon as reliable, and in a fit condition for casting, unless it had received this finishing touch.

ELECTRICAL BALL FINDING.

PROF. BELL has submitted to the Paris Academy another electric method (in addition to that of the induction balance) for detecting a projectile in the human body. It consists in inserting a fine needle near where the ball is supposed to be. This needle being connected by wire with one terminal of the telephone, while a metallic plate laid on the skin is connected with the other terminal, when the point of the needle reaches the ball a current arises (the ball and the metallic plate naturally forming a couple), and a sound is heard in the telephone. The needle may be inserted in several places with little pain, and the pain may be prevented by means of ether spray. The method has been tested on a piece of beef containing a ball. Contact of the needle with bone gave no sound, but there was a distinct sound whenever the ball was reached. The arrangement may be modified by introducing a vibrator into the circuit; a musical sound is then heard when the needle meets the ball. The circuit may also comprise a weak battery. In this case there is a sound from the moment the needle enters the skin; but at contact with the ball the sound is greatly intensified.

TELEGRAPHIC CODES AND CIPHERS.

CABLE rates to England are now 25 cents a word, but they have been as high as $100 for a ten-word message. Notwithstanding the great reductions that have been made in the cost of ocean telegraphy since the Atlantic cables were first laid, rates to points in Asia or to South America run up to several dollars a word. There are houses whose business requires frequent telegraphic communication with such distant points, and methods of attaining brevity of expression are hence of very great value. Telegraph code makers supply such methods.

"Code making as a business has grown up within the last five or six years," said J. C. Hartfield, who makes it a specialty, to a *Sun* reporter. "It has the advantages of both economy and secrecy. The use of codes for ordinary business purposes dates from the beginning of ocean telegraphy, but people at first got up their own codes. It is a very easy thing to do, apparently. All you have to do is to make a list of phrases which you have frequently to use in your business and represent them by a corresponding list of single words. But people found that words are apt to be changed in telegraphic transmission into words whose telegraphic notation is similar. The result has sometimes been disastrous. Code makers make avoidance of such liability to error a special study. Then, too, code makers can attain a condensation of expression that makes their work far cheaper than any simple code such as a business man might get up for himself. Hence, large houses are willing to pay well for having codes made for them. There are houses spending as much as $30,000 a year for telegraphic advices, and a system which will put their messages into few words effects a very great saving for them. I have made a combination code for one house here by which the entire state of the Japanese tea market can be put into seven words. Those seven words will convey to them the date of steamers sailing, the state of the market for nine grades of tea, the rates of freight by six routes, the amount of purchases for Europe and the United States, the grades upon which the demand is running, the principal buyers, rates of exchange, the number of packages sent in the day's shipments, and the points to which they are consigned. I have made a code by which the amount of sales of flour, butter, and cheese, the state of the market for each, and the amount of money paid into bank are sent daily to a house in this city by its branch at Liverpool, the whole message being put into two words."

Large houses prefer to have their own special codes. One banking house for whom Mr. Hartfield prepared a code had a printing establishment set up inside the bank building so as to make certain of receiving all the copies of the code that were printed. Some of the codes used by large houses are very voluminous. Brown Brothers & Co. have a code of 64,000 words; Thomas & Co., 67,000; Moska Bros., 60,000; Drexel, Morgan & Co., about 45,000 words.

Code makers have to employ many languages to get so many words which shall be telegraphically dissimilar. Codes cost from $30 to $6,000, according to the amount of labor required. Cryptograms or secret ciphers are used to some extent. One method used a good deal is to have a simple code, in which the words denoting the phrases to be conveyed are numbered, and simply the numerals are sent. Such a code can be used so as to conceal messages even from a person getting hold of the code, for numerals may be sent which only the proper person will understand to differ by a certain amount from the numerals denoting the phrases really conveyed. In one instance the rule was to add the date of the month to numerals of messages from a branch house. Thus, if the figure 5 came on the 20th, they would look for the meaning 25 in the code book. The use of codes and ciphers is very large, but the use of the highly condensed codes, where not only words but their combinations convey meanings, is not so wide as would be expected from its great economy. It takes some time and trouble to learn to use such codes with facility, and this retards their introduction, but they are coming more and more into use every year.

Code makers keep the details of their work secret, but the principle upon which codes are constructed is easily understood. The range of all staple business transactions has limits, and, as a rule, closely confined limits. The aim of the code maker is to classify phrases which shall express the constantly recurring details of the market for any staple, and to denote each of its phases by a word. Another object is to use one word so as to convey several meanings. This is done by arranging market details above the tops of columns of words and prices, qualities or any other information along the side. A word in the table expresses the phrase at the top of its column and also the phrase at its side. The compilation of a code is a very laborious task, but its value as an aid to business communications is indisputable.

Sometimes queer sentences result from the chance grouping of code words. Not long since a tea house got this: "Unboiled babies detested."

THE MICROPHONE IN OBSERVATORIES.*

THE idea of employing the microphone in observatories, suggested as early as the month of May, 1880, by our colleague, Mr. Van Rysselberghe, has been put, since the month of August, to a most useful application in the Geneva Observatory. This simple and wonderful instrument, by transmitting the sound of the beats of the astronomical clock from one place to another, permits of observations being made by all the instruments in different parts of the observatory by the aid of the same clock.

In a note published in the *Archives des Sciences Physiques et Naturelles*, Mr. Wilhelm Meyer, adjunct astronomer at the above-named Observatory, gives some very detailed information in regard to the installation of the microphone line, in this institution. The microphone is affixed to the outside of the clock case and is joined directly, by one of the conducting wires, to one of the poles of a Maidenger pile of medium dimensions, while the other wire of the latter communicates with the microphone after passing through the telephone and a communicator having three terminals.

The two wires coming from the telephone bobbin are very fine, and are interlaced in such a way as to form but a single flexible cord several feet in length. By this arrangement the sounds of the beats of the clock can be made to resound not only in the different parts of the hall in which it is located, but also in the neighboring rooms, owing to the length and flexibility of the cord. By this means it has been found possible to register the passages of the stars by listening, from the cupola in which the altazimuth is kept, to the beats of the clock in the telephone. A simple seconds counter or pocket chronometer serves for determining at each observation the fraction of the entire second, and the exactness of the observations made in this way is not inferior to that obtained without the intervention of the microphone and telephone.

The beats of the clock may even be heard in the tower of the great equatorial, by the aid of the same microphone and the same pile, but with a second telephone, one of whose wires is connected with the third terminal of the commutator.

The commutator permits of the current from the pile being either passed through the microphone and telephone No. 2 when it is desired to make use of it exclusively in the tower, or through telephone No. 1 when it is wished to use it exclusively in the observatory building. Finally, the current may be made to pass through the bobbins of the two telephones at the same time; in which case the beats of the clock are heard simultaneously in the building and in the tower of the great equatorial; and the intensity with which the beats are reproduced in each telephone does not sensibly differ from that which is obtained when only one is interposed in the circuit. The branches may thus be multiplied so as to have in each room of an observatory a telephone which shall reproduce the beats of one and the same clock. For all observations made by ear, a single clock will be sufficient in any astronomical establishment, of whatever extent it may be.

It is also by the aid of a microphone line established between the Observatory and the City Hall that the clock is regulated, which transmits the time to the electric dials. The beats of the regulator in the City Hall can be heard from the Observatory, in telephone No. 1; and there is, besides, a commutator arrangement which permits of setting in operation an electric bell, or a simple telephone line. With this arrangement, the transmission of time is effected as follows:

The astronomer in charge of the clocks listens in telephone No. 1 to the beats of the City Hall regulator, the fraction of the entire second of which he can readily determine, because at every full minute or sixtieth second the regulator sets in operation the auxiliary movement which establishes the electric contact for the different lines from the dials. The unlocking of this movement is heard perfectly at the Observatory. By means of the microphone line, then, a direct comparison can be made of the City Hall regulator with the Observatory clock; and in this way the error of the regulator is found with the same exactness as by comparison with a clock located in the Observatory itself. At the hour agreed upon the employe in charge of the electric clock service notifies the astronomer, by the electric bell, that he is at his post. He then connects the telephone line, and the astronomer having communicated to him through it the error of the regulator, he regulates the latter by the aid of auxiliary clocks. After this operation he opens again the microphone line so that the astronomer can make a second comparison. In this way it is found to a certainty whether the error of the regulator has been accurately corrected; and finally the results of the control comparison are telephoned back to the City Hall.

All this service is performed in from five to seven minutes, and the apparatus employed have always operated well from the very first. As may be seen, the microphone has been put, in Switzerland, to a most practical application, not only as regarded from the standpoint of astronomical science, but also from that of public utility. At the Brussels Observatory, the director, ever anxious to apply to astronomical science the most recent progresses made in others, has, since the month of December, introduced the aid of the microphone in astronomical observations. A microphone furnished by the Bell Company, and placed

* L. Niesten, in *La Nature*.

against the case of the sidereal clock, allows the beats to be heard very distinctly in different rooms and in the east tower of the Observatory.

NEOPHONOGRAPHY—A PRACTICAL SHORT-HAND FOR EVERYDAY USE.

By JAMES RICHARDSON.

THE need of a simpler, swifter, and easier mode of writing is felt by every man who has much writing to do. And the need is not likely to grow less but rather more with the constantly increasing part which letters play in the drama of civilized life. Who can think of the armies of men whose lives are devoted to the pen, and of the heavy draft upon the time and strength of professional and business men which writing involves, and not appreciate the gain that would come to social and business life through the saving even of half the time and toil which writing costs? It is hard to believe that an age so practical, so inventive, so intolerant of whatever is slow and needlessly laborious, so ready to accept anything that will help a man to two days' work in one day, will be content to leave the most used and most useful tool of civilization—writing—not merely unimproved, but really less perfect than it was two thousand years ago. The poverty of the English alphabet in forms, the uncertain values of most of its letters, and the curious misuse in our mongrel and haphazard spelling of the letters we do have, place the English writer of to-day at a disadvantage in comparison with the writers of ancient Greece, whose alphabet was at least adequate for its purpose and correctly used.

The numerous attempts that have been made to reform our traditional spelling and to devise easier and exacter modes of writing are proof enough of a common sense of the need of something better. Unfortunately they are apt to be taken as proof also that it is a hopeless task to undertake to invent a substitute for long hand that men will accept and use. Indeed, it is a common belief that the general failure of improved systems of writing so-called to win popular favor, is due chiefly to popular indifference to the benefits promised. I am not sure, however, that a more potent reason may not be found in the failure of the new systems to meet so many of the practical requirements of writing as long-hand does; a failure that may possibly be accounted for by the prominence which their inventors have given to the needs of stenographers, instead of giving most thought to the everyday needs of all writers, to whom great speed and brevity are of less importance than completeness and permanent legibility.

REQUISITES FOR PERFECT WRITING.

To stand a reasonable chance of displacing ordinary script a new writing system must be immensely its superior. It is not easy to teach old dogs new tricks; and the natural conservatism of men in matters of custom is not easily overcome. No makeshift will command respect in a case of this nature. The reform must be complete, reasonable, feasible, and worth the preliminary sacrifice, or they will have none of it.

A perfect writing system must be, first of all, strictly alphabetic. The alphabet must be a complete and sufficient key to the writing, all after-thoughts in the way of hooks, contractions, position values, vowel modes, and other stenographic devices being rigorously ruled out. Each vocal element must have one sign, each sign one value. The elements of each word must be written connectedly in the order of their pronunciation. The allotment of signs to sounds must be such as will reduce to the smallest the risk of misreading when the writing is hastily or unskillfully done. The letters must be as simple as they can be and without unmeaning pen-strokes. The writing must flow easily and freely from left to right, with the least possible deviation from the general line of the writing. Brevity as great as may consist with easy execution and certain legibility is desirable, but the writing must not be so brief as to be cramped and hard to decipher. The alphabetic elements must be such as to give distinctness and individuality of character to the written words. The organic relationships of the sounds should be represented, or at least not belied or confused, by the form relationships of the signs by which they are represented. Similar sounds should have similar signs; and those sounds which are most significant etymologically should chiefly determine the aspect of the written words.

In short, to be commandingly satisfactory, a writing system must be: 1, alphabetic; 2, phonetic; 3, cursive; 4, legible; 5, simple; 6, fluent; 7, compact; 8, distinct; 9, rapid; 10, scientific.

Whether it is possible to devise for any language a method of writing which shall meet even approximately these severe conditions will be found to depend:

a, on the number and relations of the sounds to be written, and

b, on the availability of the material which geometry furnishes for single stroke alphabetic characters.

WHAT AN ALPHABET SHOULD REPRESENT.

The learned and critical Archbishop Trench has said that the human voice is so fine and flexible an organ, is able to make such subtle and fine distinctions of sounds, so infinitely to modify and vary those sounds, that were an alphabet as complete as human art can make it, there would still remain a multitude of sounds which it could only approximately give back.

In one sense this is true, but practically it is wide of truth. Were it the business of an alphabet to represent all the nice distinctions of sound the vocal organs can utter and the trained ear discriminate, alphabetic writing would be an impossibility. But, when we consider the fact that, though the vocal organs are capable of infinitely varied juxtapositions with corresponding variations of sound, the habitual juxtapositions in speaking any language are comparatively few, and common to all to whom the language is mother tongue, it becomes evident that the proper function of an alphabet is fulfilled when it has provided signs for such common elements of the national speech. Departures from these average, standard sounds, whether due to individual or local peculiarities of utterance, or to the influence of special association with modifying sounds, may safely be disregarded in ordinary writing.

Thus, while it is not difficult to distinguish perhaps fifty more or less distinct sounds in English speech, the number necessary to be discriminated in writing is thirty-six. The rest are insignificant quantity distinctions or variations of quality through the influence of associated sounds. For example, nearly all the vowels are modified slightly when immediately followed by *r* in the same syllable. For purposes of instruction it may be useful to indicate such variations, but not in common writing.

In addition to the simple elements mentioned, there are three compound sounds of such frequent occurrence that it pays to simplify their signs, as will be shown further on.

THE ELEMENTS OF ENGLISH SPEECH.

The three dozen characteristic English sounds are indicated by the italic letters in the following familiar words:

*b*y	*v*ie	*th*y		*p*ie	*f*ie	*th*igh
*d*ay	*z*any	a*z*ure		*t*oe	*s*o	*sh*ow
*g*ay	*y*ea	*j*ay		*k*ey	*h*e	*ch*ief
	*w*ay		*l*ay		*r*ay	
	su*m*		su*n*		su*ng*	
c*a*lm	c*a*me	c*o*mb		h*a*t	h*e*m	h*u*m
c*a*ll	k*ee*l	c*oo*l		p*o*t	p*i*t	p*u*t
	n*igh*		n*ew*		n*ow*	

The quality and quantity relations of these sounds will be more plainly evident if the signs are tabulated as below:

b	v	th		p	f	th
d	z	zh		t	s	sh
g	y	j		k	h	ch
	w		l		r	
	m		n		ng	
ä	ā	ō		ă	ĕ	ŭ
a	ē	o		ŏ	ĭ	û
	ī		ew		ow	

It will be noticed that in the grouping of the eighteen consonant sounds, the voiced consonants are placed on one side, the whispered consonants on the other. The horizontal arrangement indicates relationships based on organic position in uttering the sounds; the vertical arrangement indicates the quality relationships of the sounds themselves. The members of each sub-group may be paired with the corresponding members of the other, as *b* with *p*, each pair representing very nearly the same organic position. Similar relationships will be seen in the grouping of the vowels; relationships which it may be profitable to respect in the selection of characters to represent the sounds in a new scheme of writing.

The next problem to be considered is to determine what material geometry provides for the uses of an alphabet, and how the material can be best applied.

MATERIAL AVAILABLE FOR A SCIENTIFIC ALPHABET.

It is commonly held that but two simple lines are usable for brief writing, the dash and the plain curve. I find it not only possible, but convenient and very useful, to employ also Hogarth's line of beauty, which, for short, I call a wave. In this way the available resources are increased fifty per cent, making it possible to rule out of the writing all of the stenographic devices which are otherwise inevitable, and which spoil the current systems of short-hand for popular use.

It is possible to vary the length of a single-stroke character, the direction of it, and the mode and degree of its curvature, if it have any, to an unlimited extent; but for the uses of writing the standard variations must be few and broadly defined to allow for unavoidable departures from the standard, in rapid or unskillful writing, without confusion or illegibility.

It is common in short-hand systems to use characters of five or six different sizes, as in most forms of phonography. That and other systems represent radically different sounds by the same forms struck at such slightly different angles from each other that they are not easy to distinguish, even when carefully drawn and engraved. Such systems so far disregard the primal purpose of writing—to express thoughts by means of *legible* signs. The scientific requirement, that those sounds which are etymologically most significant should chiefly determine the aspect of the written word, authorizes a marked difference in the size of vowel and consonant signs. For those sounds which fall between vowels and consonants in character and [illegible] (*w*, *l*, *r*; *m*, *n*, *ng*), signs smaller than those given to consonants and larger than vowel signs may be used. The manner in which these intermediate sounds enter into the formation of words makes them little liable to misreading, even when written much too large or much too small. We find, therefore, that three lengths of signs are both practicable and scientific.

As to direction of stroke, the practical conditions of everyday writing are as restrictive in this particular as in the matter of size. More than twenty years of critical study of the short-hand systems in print, and a multitude of unpublished experimental systems, has taught me that the best results are to be had with three standard directions of stroke: *level* with the line of writing, *slanting*, and perpendicular to the line, or *upright*. The normal slant should be about midway between level and upright, so as to allow considerable variation from the standard without risk of uncertainty as to the character intended.

It is usual, in short-hand systems, to employ right and left curvatures and right and left slants of the same form to represent radically different sounds; a practice made necessary by poverty of material when the wave is not used. Two serious evils result from this practice: the written signs are overhard to distinguish, and the rigidity of the system compels the speedy abandonment of the alphabet and the resort to all sorts of unalphabetic hooks, crooks, curlicues, contractions, and similar stenographic devices.

To secure the flexibility and grace desirable in writing, with an easy avoidance of awkward and unwritable combinations, without omission of sound or contraction of sign, the utmost freedom in curvature and slant must be allowed so long as the resulting form does not depart from its defined character. This is a special feature of neophonography. For example, a curve is "*level*" whether it is convex above or below; similarly a "slanting curve" may be struck with right or left curvature from left to right downward, from left to right upward, or from right to left downward, and still be a slanting curve. However written, its value should be constant.

Since the available forms, sizes, and directions are too few to furnish absolutely unlike signs for all the sounds to be represented, advantage may be taken of shading to distinguish those pairs of sounds which are organically alike, but differ in degree of voicing. The slight loss in speed caused by the variation of pressure for shading is offset by the relief which the changing pressure gives to the muscles of the hand, and further by the improvement of the writing incident to shading, since it prevents the flatness and monotony in the appearance of the page occasioned by an unvarying thickness of line. Another source of variety is found in the use of small stemmed circles to represent the three nasal sounds.

THE ALPHABET OF NEOPHONOGRAPHY.

The principles which have governed the allotment of signs to sounds in the alphabet of neophonography have been these—

1. To distinguish consonants, intermediates, and vowels by size;
2. To indicate similarity of vocal position by direction of stroke;
3. To give like forms to similar sounds;
4. To give to the commonest sounds the signs best suited for facile and distinct combination with those with which they must come into most frequent connection;
5. To give to the several organic groups of sounds the signs whose direction should best serve to make the writing straightforward and compact.

Hence the slanting characters have been given to the most frequently recurring sounds, with liberty to run up or down; the sounds next in frequency have level signs, and so on. With the small vowel signs experience has shown two directions, level and upright, to give the best results. By this arrangement the legibility is not impaired by a considerable divergence from the standard by accident or design, as, for example, to prevent straight vowels from blending with straight consonants. In the absence of slanting vowels, the slanting intermediates, *w*, *l*, and *r*, are not likely to be misread, even when much under size. The stems of the nasal circles always blend with the signs of their allied sounds.

THE ALPHABET.

HOW TO READ NEOPHONOGRAPHY.

For reading neophonography there is but one rule: pronounce the sounds represented by the signs in the order of their occurrence.

Those who are familiar with the vocal analysis of words are able to learn the alphabet in a few minutes, and to read fluently after a few hours' practice to familiarize themselves with the different phases of the curves and waves. Persons used to other short-hand alphabets will find the most trouble in learning the new, they will have so much to unlearn.

Those who are not familiar with phonetics will need to practice long and carefully the sounding of the elements given in the first table. They must keep always in mind, in reading, the important fact that the values of the new characters are invariable, while the sounds they represent are misrepresented in a great variety of ways by ordinary letters. The alphabetic sound of ā, for instance, is given in authorized spelling to something like fifty other letters and combinations; the alphabetic sound of ō is misrepresented by forty or more; the alphabetic sound of ē by a still larger number; and so on. Some of the consonants (*s* for example) are quite as badly treated, and none of them escapes a liberal measure of misuse.

HOW TO WRITE NEOPHONOGRAPHY.

Three rules may be laid down for guidance in learning to write neophonography, only one of them, the first, being imperative:

1. Give to each sound of the word its alphabetic sign.

Where the beginner has to learn the phonetic analysis of words while learning the new art of writing, it may be well to first set down the several signs for the sounds of new words separately, print fashion, combining them in cursive word-forms afterward.

2. Choose such curves and slants, particularly in long words, as will give the most fluent and shapely word-forms.

It is well at first to make a list of the different words written in practice, revising the list frequently to improve the combinations temporarily adopted.

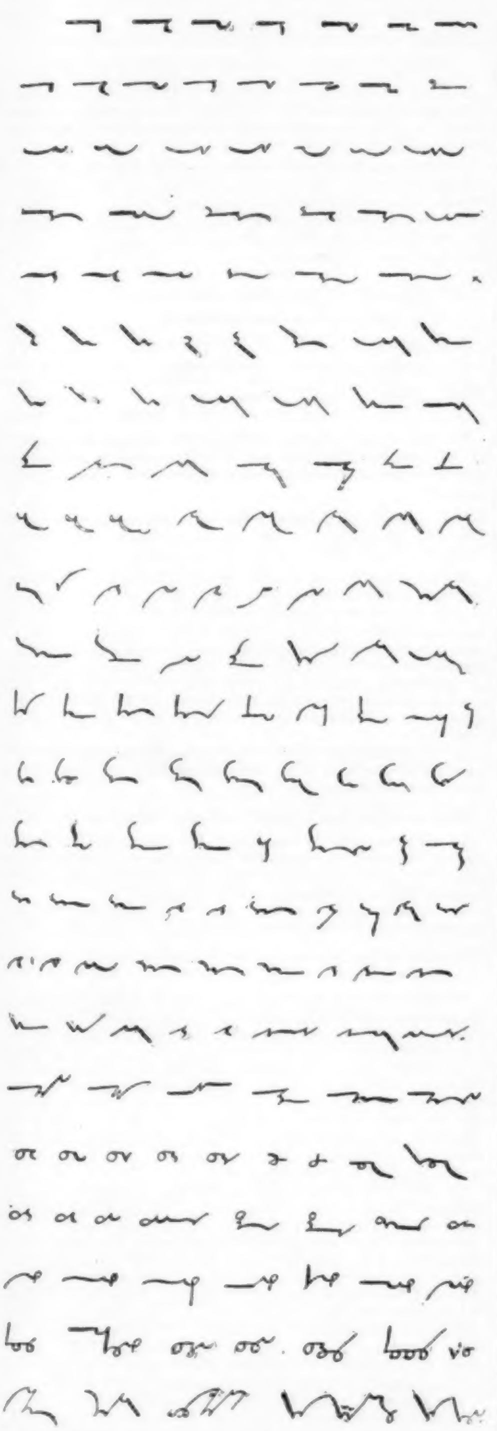
3. Throw the weight of the word-form (the vowel in short words, the level consonant, if there be any, etc.) upon the line of the writing.

Two ways of holding the pen are practicable in writing neophonography, and each gives a characteristic style to the writing. With the pen held in the usual way for running hand, the heavy slants will be more easily struck from right to left downward, giving a close style of writing. With the pen held as for back-hand, the heavy slants will be struck chiefly from left to right, giving an open style, which is less compact than the other, but, to the author's mind, much easier, (unless a very soft pen is used,) and much cleaner. Examples of the latter style, in full and abbreviated, will be found in the engraved illustrations. No anxiety need be felt on account of the lack of uniformity in the word-forms of the two styles, or for the absence of absolute conformity between the styles of different writers. So long as the spelling is correct, one form will be in the main as legible as another, though not equally desirable on the score of beauty and ease. At first the learner's writing of many words will be variable, but he will soon settle down upon those forms which lie best to his hand, and look best when written.

Those who are not familiar with the analysis of words, or

"sound reading," may be greatly helped by any common school reader or speller in which the words are grouped according to their pronunciation, or are printed with special types. The writing of sentences from dictation will be found very helpful, since, in following a reader's voice, the writer may go entirely by sound, giving no thought to the conventional spelling of the words. Where the learner has to work alone, the best plan is to write familiar passages from favorite authors from memory, especially those whose style is pure and simple. Next to that comes copying, beginning with easy poetry, Shakespeare, or parts of the Bible. Poetry is specially mentioned, because the poets are most given to simple and idiomatic English, probably because short words are the easiest to weave into verse. The superiority of neophonography is most strikingly shown in its capacity to deal successfully with long words; but the learner is apt to find such words as hard to handle as the poets do. The knack of running along the easiest lines, choosing the most facile combinations, comes rapidly with practice; and in a little while the hand seems to be able without special guidance to avoid awkward combinations. Many of the possible combinations should never appear in writing.

SIMPLE WORDS AND COMBINATIONS



The rate of learning naturally depends very much upon the learner's capacity, phonetic knowledge, and manual dexterity. A speed as great as that of the same person's long-hand has been acquired within a week, by practicing an hour or two a day. A speed four or five times as fast as long-hand is rapidly acquired if the learner is bright and young. The last qualification is an important one, as people of maturity do not so readily take up with new devices. Of course, whatever the speed, the labor of writing neophonography is not more than quarter that of long-hand.

I do not compare this writing with other short-hand systems with respect to brevity and speed for the reason that this is a full, unabbreviated, alphabetic writing; all the others which can compare with it in brevity are more or less stenographic in structure, and the function of a stenography is to hint at words, not to write them. A speed four or five times that of long-hand is ample for the ordinary purposes of life, and with that speed of execution this writing has the merit of being permanently legible to any one who knows the alphabet.

As it is impossible for the fleetest hand to keep pace with the tongue, verbatim reporting is a polite fiction, where the speaker utters his words much above the speed of ordinary talking. In such cases it is the business of the reporter to jot down a sufficient number of hints of the words to be reproduced to enable him to reconstruct more or less perfectly the whole. Obviously, the more one can write in full in a given time, the less he will have to omit to gain any higher rate of speed. But the would-be reporter must be prepared to omit a great deal on occasion. This leads to

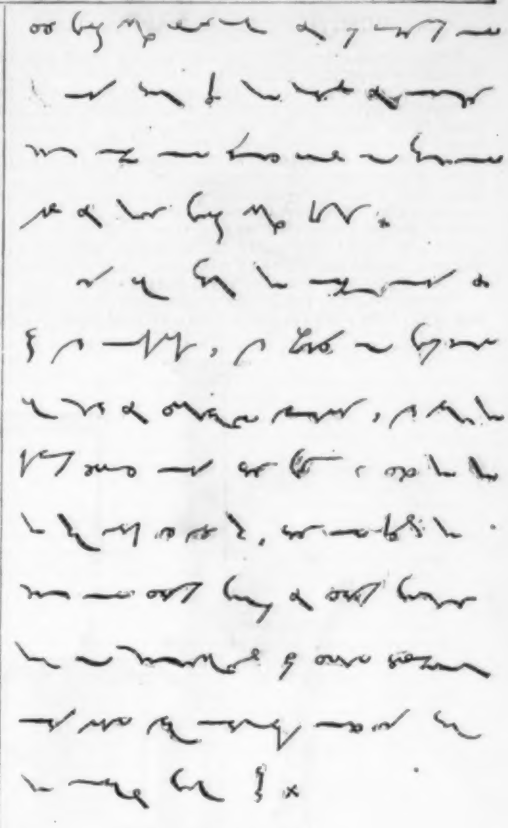
NEOSTENOGRAPHY.

As in rapid speaking we skip or slur the least significant sounds, so we must in hurried writing. When judiciously done it is possible to greatly increase the speed of writing in this way without seriously impairing the legibility of what is written. Naturally, unaccented vowels are dropped first, then those consonants the absence of which will least imperil the certainty of the reading. For a hundred or two of the most frequently recurring words it may be enough to give but a single characteristic letter. If the writer has great manual dexterity and quickness, relatively few abbreviations will be required for ordinary short-hand work. A slower writer will have to leave out more; but the abbreviation must not be carried too far. The capacity of the memory is limited, as well for writing as for reading; and one may lose more time recalling over brief signs than it would take to write the word in full. The proper balance between the work of the fingers and that of the brain in note taking must be chiefly determined by the writer's individual capacity and experience. As a rule stenographers using the same system, however well developed it may have been by its author, rarely write much alike. Each has to adapt his writing to his own hand and memory. Since the vowels suffer most in abbreviating, it is a good plan, in writing neophonography, to employ different phases of the consonants whenever possible in writing common words employing the same consonant or consonants, such as *say, see, saw, so, sigh; read, ride, rode, red,* and so on. In this way distinctive forms are left when, for rapid note taking, the vowels are dropped. It is a good plan, also, to give the remaining characters of an abbreviated word the position they have with respect to the line of the writing when the word is written in full.

When extreme brevity is desired, as for professional reporting, special value may be given to "position," as in other stenographies. Three positions are enough—above the line, on the line, through or under the line. Give the first position to straight signs, the second to curves, the third to waves. Thus a vowel sign above the line is to be read with a straight consonant not written; on the line with an omitted curve; below the line with a wave. Similarly a single consonant is read with a vowel (straight, curve, or wave,) according to its position. For example, *a* above the line would stand for *at;* on the line, for *as;* below the line, for *ash*. In like manner *s* above the line would stand for *saw;* on the line, for *see* or *say;* below the line, for *so*. By taking advantage of the six phases of the light "slanting" curve, and the three vowel positions, it is obvious that eighteen different words may be unequivocally suggested by the sign for *s*. Any large use of such arbitrary word-signs, however, is not to be recommended; they tax the memory too much, and in most cases it is easier and quicker to write a vowel connectedly than to shift the position of the consonant to indicate it. Where the vowel is inserted *after* writing the consonant stem, as in phonography, the position element is always economical not otherwise. In neophonography every motion of the hand shows on the paper and counts: in phonography each inserted vowel costs two or three movements, only one of which appears in the writing. Neophonography seems less brief on paper, though it expresses more with fewer motions.

The accompanying examples of the new style of writing will suffice to show how the writing looks, and to illustrate the principles laid down in the foregoing discussion. The rules for reading and writing neophonography are so few and simple that any intelligent student can apply them without further instruction. School readers and spellers printed phonetically may be had of any dealer in school books, and will furnish abundant material for practical exercises in case the learner is not familiar with phonetics.

For handiness of reference (and to obviate the need of printing a transcript of the writing), the first paragraph of this article has been taken to show the appearance of neophonography when written with ordinary care and skill.



THE SAME ABBREVIATED.

METHOD OF ASCERTAINING THE AGE OF EGGS.

ACCORDING to O. Leppig, fresh hens' eggs have a specific gravity of 1·0784 to 1·0942. After exposure to the air they lose water and take up air instead; by this means their specific gravity diminishes daily by 0·0017 to 0·0018. Eggs of 1·05 specific gravity are, therefore, at least three weeks old, and should no longer be purchased, as decay may have already begun. When the specific gravity has gone down to 1·015, the eggs begin to show signs of decomposition.—*Dingler Poly. Jour.*, 240, 470.

LOCOMOTIVE DISTILLING APPARATUS.

THE accompanying engraving represents a novel type of distillatory apparatus manufactured at the works of Mr. J. Joya, at Grenoble, France. The apparatus is mounted in locomotive style, and is provided with multiple stills and water-baths designed for the distillation of grape-cake, fruits, or of any solid or liquid material containing alcohol. The horizontal arrangement of the boiler secures that regularity of heat which is too often neglected in distilleries, and which alone can be the means of giving a superior product economically. The perfection of this apparatus is such that, although constructed with a view to distill alcoholic liquids, it might also easily be employed, without any changes, for the distillation of perfumes. The apparatus is capable of distilling from 130 to 175 gallons per 24 hours.

The manufacturer is likewise constructing a more simplified type of the same apparatus with a vertical boiler, which is capable of doing the same amount of work, and which is considerably lower in price than the one here figured.

LOCOMOTIVE DISTILLING APPARATUS.

RESEARCHES ON PERCHLORIC ACID.

By M. BERTHELOT.

1. THE continuation of my investigations on the oxy-acids of chlorine and of the halogen elements has led to the study of the heat resulting from the formation of perchloric acid. The results which have been obtained, but not without a great deal of difficulty, place on record a number of new chemical facts. They also show how that thermo-chemistry explains the differences of stability and of activity which exist between the pure acid and the same united to a considerable quantity of water.

2. It is already known—principally from the investigations of H. E. Roscoe—that there exist several hydrated perchlorates, namely, the monohydrated acid proper, $HClO_4$; a crystallized hydrated acid, $HClO_4.2H_2O$; and a hydrated acid, $HClO_4.4H_2O$, which is volatilized at 200°, and is partially decomposed even when distilled. I repeated these experiments, and was successful in obtaining the first acid in a crystallized form. It is sufficient to take the acid liquid, which has several hundredths of water in excess, and place it in a freezing mixture. The acid crystallizes, and the mother liquors are removed by decantation. It is allowed to liquefy and then recrystallize, and finally an acid, which is fusible at about 15°, is obtained; the fusing point is probably too high. Its composition was verified by analysis.

This compound will rapidly absorb moisture, and it fills the atmosphere with thick fumes.

3. The dissolving of the liquid monohydrated acid, $HClO_4$, in one hundred times its weight of water at 19°, yielded 20·3 calories. The experiment is sufficiently exact on account of the rapidity with which the acid absorbs moisture, even while being weighed, and in consideration of the violence of the action which takes place when it comes in contact with water at the time of the calorimetric test.

The preceding figure is enormous; it exceeds the heat of dissolving from all the other common monohydrated acids, being twice as great as that, for instance, of the hydrated sulphuric acid (H_2SO_4); it almost equals the heats produced by the dissolving of the anhydrous sulphuric acid (+18·7) and the anhydrous phosphoric acid, which are the highest which have been thus far determined; but they belong to the anhydrous compounds. The figure +20·3 equally exceeds the heats of dissolving of the hydracids, although the latter have been increased by 6 to 8 cal. on account of the gaseous condition of the hydracids.

This enormous heat produced by the solution of perchloric acid explains the difference in the reactions of this acid when diluted with water—a condition in which it is almost as stable as dilute sulphuric acid—and the reactions of the monohydrated acid, which sets fire to the hydriodic acid gas and acts with an explosive violence on oxidizable bodies. We shall return to this subject later on.

4. Perchloric acid decomposes spontaneously, as has been observed by Roscoe. At first colorless, then becoming yellow, it finally becomes red and reddish brown, and last of all, it gives off a gas, which explodes when it comes in contact with proper substances—explosions which are the more to be dreaded because in bottles stoppered by emery, the neck becomes sealed in consequence of the formation of crystals of a second perchloric hydrate.

It is well to measure the heat of hydration of that acid which underwent a partial decomposition, as it diminished more and more in consequence of the formation of water which accompanied the decomposition. Notwithstanding this formation of water, the volumetric determination of the acid agreeing with the equivalent weight of the perchloric acid did not lessen, and it may even appear to increase somewhat, for the oxygen acids of chlorine have a lower equivalent than that of perchloric acid. As this fact may prove the cause of mistakes, it is well to be aware of it.

5. An analogous decomposition is produced by heat, so that it is impossible to distill perchloric acid.

It even takes place under the conditions which ensue when perchloric acid is made from potassium perchlorate and sulphuric acid, as is shown by the incessant liberation of chlorine which accompanies the operation. The monohydrated acid, it would seem, cannot be obtained otherwise than in the form of a gas, and even then only in a very small quantity—a fact which tends to show that the decomposition of perchloric acid produces heat. Even in the preparation itself of this acid, when made from potassium perchlorate and concentrated sulphuric acid, the reaction, once started by some external source of heat, will continue of itself after the cause has been removed, and with a violence capable at times of producing an explosion, which proves that the reaction is exothermic. At the same time it gives off chlorine and oxygen, which, carrying with them the vapors of perchloric acid, render its condensation very difficult.

6. We now give some of the details concerning the oxidizing reactions produced by perchloric acid. In dilute solutions this acid is not reduced by any known body. Not even sulphurous acid, sulphydric acid, hydrosulphuric acid, hydriodic acid, free hydrogen, zinc in the presence of acids, sodium amalgam in the presence of pure water, acidulated or alkaline, nor electrolysis produces any effect. Perchloric acid and perchlorates, when dissolved, are as stable as the sulphates themselves. However, it is entirely otherwise with the monohydrated acid, because it gives off at most +20·3 calories, equivalent to its heat of solution. The hydrates $HClO_4+4H_2O$ (liquid) and $HClO_4+2H_2O$ (crystallized), of which the heat produced by dissolving corresponds in the first to only +5·3 calories to 7·7 cal. for the second,* hardly appears more active than the diluted acid itself; from tests made with the vapors of hydriodic acid and sulphurous acid, and solid arsenious acid.

The monohydrated perchloric acid behaves entirely different. Brought in the presence of an oxidizable body, sometimes it will remain almost unaffected, in the same way as nitric acid acts toward passive iron, and sometimes it will suddenly attack it with an explosive violence. It sets on fire the vapors of hydriodic acid, sodium iodide (in consequence of the previous formula of the same gas), it attacks arsenious acid in a very energetic manner, etc. With bodies containing hydrogen its action is limited by the formation of water, which changes a portion of the acid into the higher hydrate. Arsenious acid does not offer the same objections; with it there is produced an intermediate compound between this and the arsenic acid, which I have already referred to in speaking of the reciprocal displacements of oxygen and halogen bodies.† I was unable to use this reaction for the caloric measurement; even dissolving the products in soda, it was impossible to obtain a well-defined final condition of the acid. But this was unsuccessful on account of the uncertain composition of the arsenious acid which was formed, as it offered analogous differences to those presented by the various phosphoric acids. It was found that the saturation of this arsenic acid by soda produced much less heat than that of the normal arsenic acid, and it greatly inconvenienced the calculations. The following figures show the multiplicity of simultaneous methods which effect the decomposition of perchloric acid: 1·175 grammes of this acid in the presence of a large excess of arsenious acid are decomposed as follows:

0·246 gramme	gave up all its oxygen (O_4) to the arsenious acid.	
0·139	do.	formed $HCl+O_4$.
0·145	do.	gave $C+O_3+H_2O$.
0·645	do.	was found unaltered.

A few milligrammes only formed chloric acid, according to a special estimation.

7. I have measured the heat given off by the combining of perchloric acid with various bases at 18°:

$HClO_4$ (1 eq. to 6 lit.)		$+Na_2O$ (1 eq. to 6 lit.) gave off	+14·25
do.	do.	$+2^eNa_2O$	+0·07
do.	do.	$+BaO$	14·47
do.	do.	$+2^eBaO$	0·08
do.	do.	$+NH_3$ (1 eq. to 4 lit.)	12·90
do.	do.	$+2^eNH_3$	0·00

Potassium hydrate gave up the same amount of heat as the sodium, but the solutions that were used were twice as dilute in order to avoid the precipitation of the perchlorate. I also add the heat of the dissolving of the perchlorates taken from my former experiments.

ClO_4K absorbs	—12·1
ClO_4Na	— 3·5
$(ClO_4)_2B$	— 0·9

Finally, I have recently obtained the following result:

ClO_4NH_4 (1 part to 40 parts water) at 20°, —6·36

8. Now, calculating the heat resulting from the formation of perchloric acid and the perchlorates, according to their elements, from the experiments which are given in the work which I did, in common with M. Vielle,

$Cl+O_4+K=KClO_4$ solid, gives off +112·5 cal.

From this figure and from the previous results, we find:

$Cl+O_4+H=ClO_4H$ pure liquid gives off	+ 19·1
$Cl+O_4+H+\text{water}=ClO_4H$ diluted	+ 39·35
$Cl+O_4+K=ClO_4K$ dissolved	+100·4
$Cl+O_4+Na=ClO_4Na$ solid	+100·2
dissolved	+ 96·7
$Cl+O_4+H_4+N=ClO_4H+NH_3$ solid	+ 79·7

9. The following figures are obtained:

ClO_4H pure liquid		$=HCl$ gas $+O_4$ gives off	+ 2·9
do.	do.	$=Cl+O_3+H_2O$ (gas)	+ 9·9
do.	do.	= do (liquid)	+14·9
do.	dilute	$=HCl$ dilute $+O_4$	no result
do.	do.	$=Cl$ gas $+O_3+H_2O$ liquid	— 4·9

The above accounts for the difference between the stability of the concentrated acid and the dilute acid, as well as the ready decomposition of the concentrated acid. Also, there is obtained:

ClO_4K	solid	$=KCl$ solid $+O_4$	—7·5
ClO_4Na	do.	$=NaCl$ do.	—3·0
$(ClO_4)_2Ba$	do.	$=BaCl_2$ do.	—1·1

By the changing of a solid perchlorate into a chloride at ordinary temperature, heat is absorbed, that is to say, that it does not become explosive; while, according to my determinations, the contrary is the case with the chlorates. Other characteristics do not appear to have become changed with the elevation of the temperature, the molecular specific heat of potassium perchlorate, for instance (26·3), is lower than the sum of those of chlorine and oxygen (33·9); that is to say, that about 400° the mark increases by about 3 cal. of absolute value.

10. The changing of the potassium chlorate into the perchlorate by the heat is in accordance with the exothermic laws, as may be predicted, thus:

$4KClO_3=3KClO_4+KCl$, gives off at ordinary temp., +63.

In addition, this is confirmed by the thermic relations already observed between the hypochlorites and the chlorates, the latter being more stable than the first, but are also formed with a slighter absorption of heat.

11. The thermic relations equally demonstrate that the decomposition of ammonium perchlorate is explosive, for

NH_4ClO_4 solid $=Cl+O_3+N+2H_2O$ liquid, gives off +58·3 cal.
do. do. gas do. +38·3 cal.

In addition, with the fused salt, there is the heat of fusion. Experiments have established the correctness of these statements. Therefore, the ammonium perchlorate, when heated, first melts, then the liquid becomes incandescent, and assumes a spheroidal state; the brilliant globule thus produced decomposes with great rapidity into free chlorine, oxygen, and water, giving rise at the same time to a yellowish flame. However, the salt does not detonate, at least when small quantities are operated upon. These phenomena recall the decomposition of ammonium nitrate (*nitrum flammans*), but with a slightly increased intensity.

12. We have previously observed that the amount of heat produced by the dissolving (+20·3) of the hydrated perchloric acid, $HClO_4$, is very high; it is more than double that of any of the other monohydrated acids, and it is comparable to that of the most powerful anhydrous acids. This intensity of heat given off is continued up to the secondary hydrates. That of the second hydrate is: $HClO_4$ liq.$+2H_2O$ liq.$=HClO_4.2H_2O$, gives off: the hydrate being solid, +12.6 cal. about +8 6, if it is considered as a liquid. The formation of the third hydrate, $HClO_4.2H_2O+2H_2O=HClO_4.4H_2O$ liquid, gives in addition +7·4, a value which may be compared to the heat produced with the secondary sulphuric hydrate.

These numbers give support to the opinion which regards the perchloric hydrates as the last indication of the quintibasic character, already recognized in the periodic acid. These characteristics are not better explained than by the formation of the hydrates, with a large production of heat, the perchloric acid produces only the monobasic salts. I have already shown in another series, RO_3H, how the monobasic acids, chloric and nitric, to the tribasic phosphoric acid by iodic acid, which presents many intermediate characteristics.* These researches show how thermo-chemistry accounts for the peculiar properties and especially for the singular opposition which exists between oxidizing reactions of the concentrated acid, which are so energetic, and the great stability of the diluted acid.—*Comptes Rendus*, xciii., 240.

REACTION FOR GALLIC ACID.

AMMONIUM picrate produces in solutions of gallic acid a red coloration, which in a few seconds passes into a fine green. Pyrogallic acid and tannin give also a red, which remains unchanged.—*Polyt. Notizblatt.*

* About +11·7 in its liquid condition.

† *Annales de Chimie et de Physique*, 5th Series, vol. xv., p. 211.

* *Annales de Chimie et de Physique*, 5th Series, vol. xii., pp. 313, 314.

ON THE ESTIMATION OF THE DRIED RESIDUE FROM WINES.

By M. L. DE SAINT-MARTIN.

M. MAGNIER, of Source, has complained of the inaccuracy of the old method used for the determination of the dried residue of wines.* A little later M. Gautier took up these criticisms, and materially emphasized them by the proposition of a new method of estimation, consisting of the evaporation of 5 c.c. of the wine to be tested in vacuo, at first in the presence of sulphuric acid, and finally over phosphoric anhydride.† I have recently had occasion to study the old method and that of M. Gautier, and I find that:

1. The inaccuracy of the old method has been considerably exaggerated, and that when practiced under certain conditions it yields very good results; and

2. That the estimation of the residue from wine obtained by evaporation in vacuo is not entirely free from objections.

I. It is proper to observe at the beginning that the method which M. Gautier used in studying the process which he condemned was not the method generally described; in fact, he evaporated his samples in the presence of a porous body (pumice stone, asbestos, or silica). Pasteur, Balard, and Wurtz are also in favor of the employment of a body such as potassium sulphate in order to produce the desiccation of the wine.‡ But it is evident that, if the addition of a foreign substance, by increasing the surfaces, serves the purpose of hastening the evaporation of the water and alcohol, it will also favor the evaporation of other bodies less volatile that are contained in the residue of wine (glycerine, succinic acid, ethers. It is, above all, this fact that sustains the experiments of M. Gautier. If wine is evaporated in a drying oven at 100°, without the addition of any foreign substance, there will be obtained at end of eight or ten hours a residue which will differ but very slightly in weight from one which has been submitted to a much longer desiccation. It is only necessary to examine the following table to prove the correctness of the previous statement; the figures were obtained by evaporating 5 c.c. of each wine in a numbered platinum capsule. The weights are within one-tenth of a milligramme.

Name of Wine.	The weight of the residue from a liter of wine after having been in the drying oven for:				
	4 hours.	6 hours.	8 hours.	10 hours	15 hours
	grms.	grms.	grms.	grms.	grms.
Casseneuil..... ..1878	20·10	19·60	19·25	19·20	18·95
Pomard..........1874	23·61	23·16	22·86	22·73	22·41
Margaux..........1874	22·10	21·65	21·35	21·18	20·82
Chablis 1878	19·35	18·75	18·65	18·35	18·15

Thus it will be seen that it would be very easy to multiply examples to show that the weight of the solid residue of wines, after being left in a drying oven for from eight to fifteen hours, diminishes not more than 0·5 gramme to the liter; so that the old method, operated in the way which has just been described, will yield results fully as satisfactory as those produced by evaporating in vacuo, as may be seen by comparing the tables given by M. Gautier himself.§ Besides, this chemist regarded the weights of his residues as constant when they did not diminish by more than several decigrammes to the liter (samples ix. to xii.).

II. I have tried, and that was the origin of this work, to rapidly estimate the dried residue of wines in a current of air which had been dried and was rarefied at a temperature not exceeding 50°. In this manner I had hoped to combine all the advantages of the Gautier method, and, in addition, obtain results more rapidly For this purpose I measured, or weighed, in a small flat-bottomed flask, provided with a hollow glass stopper, ground in with emery, 5 c.c. of the wine to be analyzed. The flask was then placed in a water bath, the temperature of which was kept at 48° to 50° by the aid of a Kemp's regulator, and the glass stopper replaced by a rubber cork having two holes. Through one of these holes a bent tube was passed, which extended down to the center of the flask and communicated by means of its horizontal branch with a wash bottle which was half filled with concentrated sulphuric acid; through the other hole a second bent tube was passed, whose vertical extension scarcely went more than through the cork, and whose horizontal branch was connected with a Goloz tromp. The immersed tube of the wash bottle (for it was the other which communicated with the flask containing the wine destined to be evaporated) had on its free extremity a rubber closed by a pinchcock. By means of the tromp, a vacuum as complete as possible was made; then slightly opening the pinchcock, air, bubble by bubble, was allowed to enter the wash bottle. In this manner the entire apparatus was soon traversed by a current of dry air under a pressure of four to five centimeters. By methods easy to imagine, but entirely unnecessary to describe at this place, it was possible to simultaneously operate on four samples of wine. This apparatus is very convenient for evaporating at low temperatures and under feeble pressure. The writer uses it daily in determining the dried residue of milk, wine, etc. In regard to the wine, at the end of five or six hours a residue of fine color was obtained, and whose weight was almost constant. Some figures are herewith given, and the selection is made from wines which have already been referred to:

Name of Wine.	Weight of the residue from a liter after exposure to a current of dry air under a pressure of 5 cm. after:			
	2 hours.	4 hours.	6 hours.	8 hours.
	grms.	grms.	grms.	grms.
Casseneuil.......1878	22·34	22·14	22·00	22·00
Pomard.........1874	27·80	27·14	27·12	.....
Margaux.... .. 1874	24·92	24·83	24·80	.....
Chablis...........1878	22·08	21·58	21·54	.....

These results could hardly be more satisfactory; but it seemed desirable to compare them with those obtained by M. Gautier's process. For this purpose I had mounted an apparatus, constructed exactly after the description of that chemist, and I placed my samples in a vacuum for five days in the presence of sulphuric acid, and then for ten days longer with a fresh quantity of sulphuric acid and a large quantity of anhydrous phosphoric acid, all at a temperature of 13° to 14° C. The following results were obtained:

Name of Wine.	Weight of residue obtained in a dried vacuum calculated to the liter of wine.
Casseneuil.........1878	..............23·20 grammes.
Pomard..............1874	..............27·52 "
Margaux.............1874	..............25·20 "
Chablis.. 1878	....21·48 "

If these figures are compared with those of the preceding table, it will be easy to see that, with the exception of the white wine, the weight of the residue obtained in a vacuum at 50° is less than that obtained in the cold at 14°. The coloring matter seems to play a certain role in the variations of the weights of the residue with the temperature, and that which tends to prove the above is the fact that the older wines of Pomard and Margaux were slightly colored, and that for them the difference is much less than for the other sample, which was a wine used for ordinary purposes, strongly colored, for which it is far from being inappreciable. Although the following was not verified by actual experiment, still it appears probable that at a temperature somewhere between 14° and 50°, say 35°, for example, intermediate results will be obtained. It is, therefore, very evident that a difference between the results obtained in winter and those in summer will ensue when M. Gautier's apparatus is used. Now, if we examine the relation which exists between the weight of the dried residue, remaining from 5 c.c. which has been exposed for ten hours at 100° without the addition of a foreign body, and that from the same wine resulting from exposure in the cold in a vacuum, we find:

For the wine of	Casseneuil...........	0·8276
"	Pomard.......	0·8262
"	Margaux	0·8213
"	Chablis..................	0·8575

These figures differ quite materially from those given by M. Gautier, who obtained results varying between 0·789 and 0·759. It is evident that the enormous differences which exist between the figures obtained at 100° and those obtained in the cold can not be entirely attributed to the volatilization of the glycerine, succinic acid, and the ethers. Thus the fact remarked by M. Gautier, "the dissociation of unstable compounds, such as certain hydrates," and in particular the state of hydration of the coloring matter (see above), certainly have a very great influence in these variations.

III. I consider myself justified in drawing from these researches, which I desire to extend and render more complete, the following conclusions:

1. The old method for the estimation of the dried residue of wines will give comparative and satisfactory results when five cubic centimeters of wine are dried at 100°, for ten hours in a drying oven, without the addition of any porous or dividing body.

2. The method of M. Gautier is decidedly to be preferred, insomuch as it yields results leading to a fixed limit, but it is more delicate in its application and especially longer in its manipulation, above all in winter; it appears, however, not to be without objections, and differences are obtained according as the operation is conducted in the cold of winter or in the heat of summer.

3. It is always imprudent to deduct from the weight of the dried extract obtained in vacuum the weight from that obtained by drying the same wine at 100°.

4. It is greatly to be desired that a uniform method for the estimation of the residue of wines may be adopted. It is in all cases absolutely indispensable, in giving results, to state by what method they were obtained.—*Bulletin de la Société Chimique de Paris*, vol. xxxvi. p. 139.

* "Bulletin de la Société Chimique," 26, 489.

† *Idem.*, 26, 16, and "Sophistication of Wines."

‡ It would appear as if these illustrious chemists, in the course of their experiments, had stopped the process of desiccation, not after having obtained constant weights, but at the moment when the moisture ceases to go off, for otherwise they certainly would found the weight of the residue less or not as high as would have been the case had the operation been performed without the addition of potassium sulphate.

§ "Sophistication des Vins," p. 150.

CRYSTALLIZATION.

AT at recent meeting of the Bath Microscopical Society, Mr. Braham, F.C.S., introduced a new microgoniometer for measuring the angles of crystals. The body of the microscope tube was formed at right angles. A rectangular prism is so adjusted that the plane of the hypothenuse is at an angle of 45 degrees to the axis of rotation. On bringing any crystal into the center of the field, a fiber in the focus of the eyepiece is made to coincide with either of its edges so that the degrees passed through can easily be read. Thus, as the instrument measures a magnified image of the crystal, and the object itself is stationary, it will readily be seen that the angles of any crystal visible under the highest powers of the microscope can easily be measured. Mr. Braham then gave an address on the transparent crystals formed by the action of metals on carbon disulphide. The experiments which he had carried out were explained as follows:

Mr. Braham had sealed up, in glass tubes, fifteen different metals in carbon disulphide, and had subsequently examined them under the microscope. One year from the date of sealing them there were appearances of incipient crystallization in most of the tubes. After two years' rest, the tubes containing gold, antimony, and bismuth showed transparent crystals, the shape of which coincided with the form which carbon takes in the diamond.

Mr. Braham then recapitulated his experiments, shown to the society from time to time, all of which were upon crystallization or analogous subjects. He considered crystallization to be one of the grandest studies that the chemist and physicist can pursue, and one in which the microscope played a most important part, for by its use the time at which crystals were to be discovered was shortened. He considered crystallization to be the first effort of matter in building up a structure, and to observe the manner in which crystals form under the microscope, we have ocular demonstration of the energy exerted by matter under certain chemical and physical conditions. Speaking of the time which was required to produce such crystals as diamonds of large size, he gave it as his opinion that it was impossible to conceive the time they had taken to form, and their purity depended on circumstances of large masses of matter in a solution crystallizing heterogeneously until nothing but the pure element was left, and that a slow process of formation through ages completed it. At the close of the address the sealed tubes were exhibited under glasses.

LUBRICANTS.

IN answer to a number of correspondents we publish the following:

The desirable features of a good lubricant or unguent may be briefly stated thus: It should, first of all, reduce friction to a minimum, should be perfectly neutral, and of uniform composition. It should not become gummy or otherwise altered by exposure to the air, should stand a high temperature without loss or decomposition, and a low temperature without solidifying or depositing solid matters. The question of cost and adaptability to the requirements of light or heavy bearings are also important considerations.

The finest lubricating oils in the market—those used for watch, clock, and similar delicate mechanism—are chiefly prepared from sperm oil by digesting it in trays, with clean lead shavings, for a week or more. Solid stearate of lead is formed, and remains adhering to the metal, while the oil becomes more fluid and less liable to change or thicken on chilling.

Sperm oil is used for lubricating sewing machines and other light machinery. Some of the oils sold for this purpose contain cotton seed oil and kerosene, and others are composed largely of mineral, sperm, or signal oil—a heavy, purified distillate of petroleum.

Good heavy lubricating oil is made from heavy paraffine oil (a distillate of petroleum). Owing to "cracking" (decomposition of the vapors of the heavy distillate into lighter products), which takes place in the still, the crude oil contains a large per cent of light offensive oils, too thin for lubricating purposes. In Merril's process these are separated by blowing superheated steam through the oils, heated just short of its boiling point in the still, the lighter oils being driven off, a neutral, nearly odorless, heavy oil, gravity 29° B. to 26° B., and boiling at about 575° Fahr., remaining. When mixed with good lard oil it makes an excellent and cheap lubricant.

Common heavy shop and engine oils are commonly variable mixtures of heavy petroleum or paraffine oils, lard oil, whale or fish, palm, and sometimes cotton seed and resin oils. There are nearly as many of these composite oils in the market as there are dealers in such supplies. The following is one of them:

Petroleum..............................	30 per cent.
Paraffine oil (crude)..................	20 "
Lard oil................................	20 "
Palm oil...	9 "
Cotton seed oil........................	20 "
	99

Solid or semi-solid unguents, such as mill and axle grease, etc., are prepared from a variety of substances. The following are the compositions and methods of compounding a few of these:

Frazer's axle grease is composed of partially saponified rosin oil—that is a rosin soap and rosin oil. In its preparation, one half gallon of No. 1, and two and one-half gallons of No. 4 rosin oil, are saponified with a solution of one-half pound of sal soda dissolved in three pints of water, and ten pounds of sifted lime. After standing for six hours or more, this is drawn off from the sediment and thoroughly mixed with one gallon of No. 1, three and one-half gallons of No. 2, and four and two-third gallons of No. 3 rosin oil. This rosin oil is obtained by the destructive distillation of common rosin, the products ranging from an extremely light to a heavy fluorescent oil or colophonic tar.

Pitt's car, mill, and axle grease is prepared as follows:

Black oil or petroleum residuum......	40 gallons.
Animal grease........................	50 pounds.
Rosin, powdered......................	60 "
Soda lye...............................	2½ gallons.
Salt, dissolved in a little water... ...	5 pounds.

All but the lye are mixed together and heated to about 250° Fahr. The lye is then gradually stirred in, and in about twenty-four hours the compound is ready for use.

Hendricks' lubricant is prepared from whale or fish oil, white lead, and petroleum. The oil and white lead are, in about equal quantities, stirred and gradually heated to between 350° Fahr. and 400° Fahr., then mixed with a sufficient quantity of the petroleum to reduce the mixture to the proper gravity.

Munger's preparation consists of:

Petroleum...	1 gallon.
Tallow..................................	4 ounces.
Palm oil....	4 "
Plumbago..............................	6 "
Soda	1 ounce.

These are mixed and heated to 180° Fahr. for an hour or more, cooled, and after twenty-four hours well stirred together.

A somewhat similar compound is prepared by Johnson as follows:

	Liquid.	Solid.
Petroleum (30° to 37° gravity)......	1 gall.	1 gall.
Crude paraffine..............	1 oz.	2 oz.
Wax (myrtle, Japan, and gambier).	1½ oz.	7 "
Bicarbonate of soda................	1 oz.	1 "
Powdered graphite..............	3 to 5 "	8 "

Maguire uses, for hot neck grease:

Tallow.............	16 pounds.
Fish	60 "
Soapstone...........................	12 "
Plumbago............................	9 "
Saltpeter............................	2 "

The fish (whole) is steamed, macerated, and the jelly pressed through fine sieves for use with the other constituents.

Chard's preparation for heavy bearings consists of:

Petroleum (gravity 25°)........	12 ounces.
Caoutchouc........................	2 "
Sulphur..............................	2 "
Plumbago..........................	4 "
Beeswax............................	4 "
Sal soda............................	2 "

This composition is stirred and heated to 140° Fahr. for about half an hour.

The following are a few of the compositions for lubricating that have been patented:

Petroleum residuum, alkali, ammonia, and saltpeter.
Graphite, oil, caoutchouc.
Asbestos and grease.
Lignumvitæ and spermaceti.
Ivory dust and spermaceti.

Tin and petroleum.
Zinc and caoutchouc.
Plastic bronze and caoutchouc.
Tallow, palm oil, salts of tartar, and boiling water.
Oil, lime, graphite, castor oil.
Shorts, soapstone, and castor oil.
Petroleum residuum, salt, caustic potash, sal ammoniac, spirit of turpentine, linseed oil, and sulphur.
Petroleum residuum and flour.
Petroleum residuum, lard, sulphur, and soapstone.
Mixed heavy and light petroleum.
Oil, wax, caoutchouc, rosin, and potash.
Petroleum residuum, sal soda, sulphur, and kerosene.
Glycerine, graphite, asbestos, kaolin, manganese, soapstone, sulphide of lead, carbonate of lead, and cork.
Saponified resin, wheat flour, petroleum, animal fat, and soda.
Type metal and caoutchouc.
Anthracite coal and tallow.
Tin oxide and beeswax.
Soapstone, magnesia, lime, and oil.
Sulphur and petroleum.
Vulcanized caoutchouc, petroleum, and tallow.
Paraffine oil and milk of lime.
Asbestos and tallow.
Spermaceti and India-rubber.
Tallow, petroleum, soda, and hair.
Mercury, bismuth, and antimony.
Petroleum, sal soda, lime, tallow, lard, salt, pine tar, turpentine, camphor, and alcohol.
Sulphur, plumbago, mica, tallow, and oil.
Palm oil, paraffine, tallow, alkali, and asbestos.
Tallow, oil, paraffine, and lime water.
Flax seed oil, cotton seed oil, tallow, and lime water.
Petroleum, tallow, beeswax, soda, and glauber salt.
Animal oil, croton oil, spermaceti, tallow, soda, potash, glycerine, and ammonia.
Sheets of paper or woven fabrics impregnated with graphite, steatite, paraffine, tallow, size, and soluble gums.

BUTTER COLORING.

IT is a fact not generally known that much—it might be said nearly all—of the butter offered for sale in our large cities owes its "rich golden color" to artificial additions. The dairyman, as well as the butter dealer, has found that butter of a *good color* commands a readier sale than pale butter, and as a color is so easily and cheaply procured the temptation to improve (or, at least, to equalize) the natural tint of the commodity is not to be resisted. As long as the coloring matters used are harmless there can be no valid objection urged against the practice, and we have no reason to believe that anything really pernicious has thus been introduced into our food—at least of late years.

The coloring matters commonly employed are annatto and turmeric, or extracts of these; but there are also a number of butter-coloring compounds or mixtures sold for this purpose. For some of these it is claimed that they will not only impart the desired color to butter, but will keep it sweet and *fresh* for an indefinite time. The following are a few of these coloring compounds in use at present. Rorick's compound is prepared as follows:

The materials for 1,000 pounds of butter are:

Lard, butter, or olive oil	6	pounds.
Annatto	6	ounces.
Turmeric	1	ounce.
Salt	10	ounces.
Niter	½	ounce.
Bromochloralum	3½	ounces.
Water	q. s.	

The lard, butter, or oil is put into a pan and heated in a water bath. The annatto and turmeric are then stirred into a thin paste with water, and this is gradually added to the fatty or oily matters kept at a temperature of about 110° Fah. The salt and niter are next stirred in, and the mixture heated to boiling. The heating is continued for from twelve to twenty-four hours, or until the color of the mixture becomes dark enough. The bromochloralum is then introduced and the mass is agitated until cold, when it is put up in sealed cans.

Bogart's preparation is prepared as follows:

The materials employed are:

Annattoine	5	ounces.
Turmeric (pulverized)	6	"
Saffron	1	ounce.
Lard oil	1	pint.
Butter	5	pounds.

The butter is first melted in a pan over the water bath and strained through a fine linen cloth. The saffron is made into a half pint tincture, and, together with the turmeric and annattoine, is gradually stirred into the hot butter and oil and boiled and stirred for about fifteen minutes. It is then strained through a cloth as before and stirred until cool.

Dake's butter coloring is prepared by heating a quantity of fresh butter for some time with annatto, by which means the coloring matter of the butter is extracted, and straining the colored oil and stirring it until cold.

THE PREVENTION OF NUISANCE FROM GAS PURIFIERS.

THE difficulty of dealing with the fumes arising from freshly opened gas-purifiers has been met by M. Lebreton in a manner which is claimed to be effective and economical. In M. Lebreton's works, when a purifier-box is thrown out of use, a fan or ejector is employed to drive a large quantity of air through the spent material, which, if of oxide of iron, is thereby revivified. The air thus saturated with ammoniacal and sulphur compounds is driven forward into a saturator full of sulphuric acid, where it parts with its ammonia in the usual form. In the first plant of this kind set up by M. Lebreton he was content to prevent a too violent ebullition of acid, and to cause the division of the stream of air into fine bubbles, by wrapping the end of the pipe with woollen rags. He has probably since improved the arrangements for bringing the gas and liquid into intimate contact. M. Lebreton has thus succeeded in producing large quantities of sulphate of ammonia, from the ventilating air from his purifiers, which would otherwise have escaped into the atmosphere, and probably caused a troublesome nuisance to the neighborhood. It should be added that the success of M. Lebreton in economically dealing with the purification of large quantities of air wherein the constituent of ammonia was very small, formed the incentive to M. Chevalet to attempt the similar treatment of chimney gases.—*Journal of Gas Lighting.*

JAPANNING AND JAPANS.

WHEN finished wood, papier-mâché, composition, or materials are varnished in the usual manner and left to dry in the air, the drying is in most cases imperfect, and the coating more or less uneven. If the surface thus varnished is heated for some time to a temperature of from 250° to 300° Fah. or higher, it is found that the whole of the solvent or vehicle of the gums or resins in the varnish is soon driven off, and the gummy residue becomes liquefied or semi-liquefied, in which state it adapts itself to all inequalities, and if the coating is thick enough presents a uniform glossy surface, which it retains on cooling. This process of drying out and fusion secures a firm contact and adhesion of the gums or resins to the surface of the substance varnished, and greatly increases the density of the coating, which enables it to resist wear and retain its gloss longer.

This process of hardening and finishing varnished or lacquered work by the aid of heat constitutes the chief feature of the japanner's art.

In practice the work to be japanned is first thoroughly cleansed and dried. If of wood, composition, or other porous material it is given while warm several coats of wood filler, or whiting mixed up with a rather thin glue size, and is, when this is hardened, rubbed down smooth with pumice stone. It is then ready for the japan grounds. Metals as a rule require no special preparation, receiving the grounds directly on the clean dry surface.

In japanning, wood and similar substances require a much lower degree of heat and usually a longer exposure in the oven than metals, and again a higher temperature may be advantageously employed when the japan is dark than when light-colored grounds are used; so that a definite knowledge of just how much heat can be safely applied and how long an exposure is required with different substances and different grounds can only be acquired by practical experience.

The japanner's oven is usually a room or large box constructed of sheet metal, and heated by stove drums or flues, so that the temperature—which is indicated by a thermometer or pyrometer hung up inside, or with its stem passing through the side wall midway between the top and bottom of the chamber—can be readily regulated by dampers. The ovens are also provided with a chimney to carry off the vapors derived from the drying varnish, a small door through which the work can be entered and removed, and wire shelves and hooks for its support in the chamber. The ovens must be kept perfectly free from dust, smoke, and moisture.

A good cheap priming varnish for work to be japanned consists of:

Shellac (pale)	2	ounces.
Rosin (pale)	2	"
Rectified spirit	1	pint.

Two or three coats of this is put on the work in a warm dry room. A good black ground is prepared by grinding fine ivory black with a sufficient quantity of alcoholic shellac varnish on a stone slab with a muller until a perfectly smooth black varnish is obtained. If other colors are required the clear varnish is mixed and ground with the proper quantity of suitable pigments in a similar manner: for red, vermilion or Indian red; green, chrome green or prussian blue and chrome yellow; blue, prussian blue, ultramarine, or indigo; yellow, chrome yellow, etc. But black is the hue commonly required. The following are good common black grounds:

1. Asphaltum	1	pound.
Balsam of capivi	1	"
Oil of turpentine	q. s.	

The asphaltum is melted over a fire, and the balsam, previously heated, is mixed in with it. The mixture is then removed from fire and mixed with the turpentine.

2. Moisten good lampblack with oil of turpentine, and grind it very fine with a muller on a stone plate. Then add a sufficient quantity of ordinary copal varnish and rub well together.

3. Asphaltum	3	ounces.
Boiled oil	4	quarts.
Burnt umber	8	ounces.
Oil of turpentine	q. s.	

Melt the asphaltum, stir in the oil, previously heated, then the umber, and when cooling thin down with the oil of turpentine.

An extra fine black is prepared from:

Amber	12	ounces.
Asphaltum (purified)	2	"
Boiled oil	½	pint.
Resin	2	ounces.
Oil of turpentine	16	"

Fuse the gum and resin and asphaltum, add the hot oil, stir well together, and when cooling add the turpentine.

A white ground is prepared from copal varnish and zinc white or starch. Large japanners seldom make their own varnishes, as they can procure them more cheaply from the varnish maker.

From one to six or more coats of varnish are applied to work in japanning, each coat being hardened in the oven before the next is put on. The last coat in colored work is usually of clear varnish, without coloring matters, and is in fine work sometimes finished with rotten stone and chamois. For ordinary work the gloss developed in the oven under favorable conditions is sufficient.

LIMITS OF ELECTROLYSIS.

IT is known that the researches of Joule and Favre have established relations between the electro-motor forces and the combining-heats of the metals, but the application of these laws to the electrolysis of salts is often very obscure, especially when secondary actions are produced, and it is required to know the exact sum of all the energies which concur in the electrolytic phenomenon. Physicists admit at present that the electrolysis of potassium sulphate takes place in the same manner as that of copper sulphate. The metal goes to the negative pole, and the sulphuric acid to the positive. If the metal does not decompose water, it is precipitated on the electrode; otherwise it is replaced by hydrogen, as happens with potassium sulphate. The electro-motor force necessary to produce the electrolysis may be calculated in three different manners, which the author gives in detail, and the last of which agrees with his experimental results.—*M. Berthelot.*

NEW RESEARCHES ON PHARMACEUTICAL SIRUPS.

THE Italian Professor of Pharmacy, Signor Prota-Giurleo, has written a paper upon pharmaceutical sirups, and on a new method of insuring their preservation. The latter portion of the author's memoir interests us very much, and we hasten to give the results of his investigations.

In the first place he shows that the various decompositions or fermentations to which pharmaceutical sirups are subject often react upon the active medicinal principle dissolved in them. He classes the fermentations observed in sirups into viscous, butyric, mucic, tannic, amylic, pectic, acetic, etc., according to the substance which is produced in largest quantity.

Many decompositions are to be traced to fraud or adulteration, he tells us, when certain substances are used in place of those which are prescribed by the official codex; for instance, when sirup of citron is replaced by citric acid and simple sirup, and when fruit sirups are adulterated or replaced by tartaric acid and *phytolacca* berries; when, instead of sirup of prunes, a mixture of simple sirup with aniline violet and tartaric acid is used! etc.

A great number of pharmacists have devoted their attention to the keeping qualities of medicinal sirups, and various substances have been proposed with the view of enhancing this much-desired quality; among others we may mention glycerine, alcohol, sulphites, hyposulphites, chloral hydrate, salicylic acid, thymol, phenol, filtered air, etc. Much success has attended in France the use of a small quantity of the distilled water of *Spiræa ulmaria*, made known a few years ago by Patrouillard for preserving the sirups of the alkaloids and their salts.

Professor Giurleo asserts that all these methods are fraught with a certain amount of inconvenience, and he has endeavored to find some better means of rendering pharmaceutical sirups quite inalterable, so that the physician may be perfectly certain that the product he employs is always pure, always the same, and quite devoid of the liability to decompose. With this view he divides pharmaceutical sirups into three classes.

1. Those sirups which contain a well-defined chemical principle, such as a base, an acid, or a salt.

2. Sirups which contain a balsam, a resin, or some analogous principle.

3. Sirups containing a principle which must be extracted by boiling or by some simpler method, such as extracts of roots, bulbs, rhizomæ, barks, flowers, leaves, fruit, etc.

Those of the first and second classes can be preserved for a long time without any decomposition whatever, by the methods now used in their preparation. It is, therefore, on the third class that the author's researches bear more particularly.

The spoiling of the sirup of the third class is due to various causes; among others, to the presence of caseine, albumine, fibrine, gum, gluten, starch, sorbine, mannite, etc., which he admits gives rise to different kinds of decomposition in contact with sugar and water. The various experiments which the author has made with antiseptics, such as sulphites, hyposulphites, boracic acid, borate of soda, chloral, salicylic acid, and a few others have not given him results as satisfactory as he could have desired. But on the other hand wine vinegar has yielded in his hands the most satisfactory results; it is the only substance which he has found capable of preserving for a lengthened period the sirup of squills and of colchicum. He would prefer to prepare the sirups with wine vinegar if the process did not present certain drawbacks, but he proposes instead to use white wine.

The sirups of red poppy, of squills, of polygala, etc., prepared in this way, have been preserved for upwards of twenty months without the slightest trace of decomposition, although they have been exposed to the action of air, sunlight, and dust. The process is carried out as follows:

The medicinal substance is inclosed in a stout bottle, pure white wine is added to it, and the bottle is placed in a water bath, where it is heated from 40° to 80° C. The mixture is cooled and pressed, and to the filtered liquid a mixture of white sugar 1,000, and water 300, is added, so as to make 1,500 parts of sirup. The author pretends that this treatment with pure white wine, extracts the whole of the active principles, and that the sirup thus prepared is not liable to decomposition by keeping. There is no doubt that the process may prove valuable in many cases, but perhaps not in all. It is a subject that deserves looking into, as Professor Giurleo claims to have solved a most important pharmaceutical problem.—*Monthly Magazine.*

"THE CUP THAT CHEERS."

DR. LUTON writes in the *Bulletin Général de Thérapeut.*, 1881, Number VI. (quoted by *Med. Obozr.*): "By chance I prepared a mixture whose physiological effects are remarkably like those of protoxide of nitrogen (laughing gas). It is a combination of phosphate of soda with tincture secalis cornuti.

"In Ward L of the Reims Hospital, a woman, aged sixty-two, was taking tincture of ergot for subacute arthritis of the right knee. In order to increase the effect of the medicine, I added to it some sodic phosphate. In a quarter tumblerful of sugared water the patient was given a teaspoonful of tincture of ergot and a tablespoonful of a ten per cent. solution of phosphate of soda. In three-quarters of an hour, without any apparent cause, the patient had an attack of hilarity and laughter, which lasted about half an hour, and returned several times. She appeared as if intoxicated and her pleasurable feelings remained for some length of time after the stage of excitement proper. She was given the same mixture several times, and always with the same results.

"Another patient, suffering from a chronic affection, on noticing the effect of the medicine on the first mentioned patient, wished to have it tried on herself. She was given the same dose, and in a quarter of an hour she had an attack of pleasurable excitement and laughter, more intense and more prolonged than the other woman. Manifold repetitions of the experiment produced the same results.

"A third patient, a single female, aged seventy, with decided hypochondria, was given the same dose of the mixture, and in three-quarters of an hour had an attack of immoderate laughter, merry talking, and stamping of the feet. She said she felt very happy. Even on the second and third day the recurrence of the symptoms was plainly noticeable, although she had not been given any more of the medicine.

"Another patient, a chlorotic, hysterical girl of nineteen, in three-quarters of an hour experienced a pleasant warmth all over the body, with great cheerfulness and slight intoxication, like that which follows on generous wine; also attacks of laughter. She seemed to be in a most happy

mood." The doctor continued his experiments and found that the mixture produced the same effect on healthy women, old men, and children. On men it acts much less; the same dose produces in them only a flushing of the face. He did not give any one a larger dose, but thinks the same effects could be induced in men.

How and why does this mixture act in this manner? This question the author does not answer yet. We know that ergot (apart from its characteristic convulsions) has a powerful influence on the brain and the nerve centers. In rainy years, when the rye in Russia contains sometimes over five per cent. of ergot, the bread made from rye not infrequently induces slight intoxication. Perhaps the phosphate of soda increases this effect on the brain. Perhaps from the mixture of the two drugs a new substance results, with an effect similar to hasheesh.

The author's formula for the mixture is as follows:

℞. Tinct. secalis cornuti	5	0 (ʒ j. +gr. xvi.)
Solutionis phosphatis sodæ, 10 per cent.	15	0 (f. ℥ ss.)

M. S. Drink all on an empty stomach, in a quarter tumblerful of sweetened water.

The author suggests that the mixture may be very useful in certain diseases, as hypochondria, melancholia, nervous chills of the hysterical, the algid stages of fevers and cholera, since the remedy evidently increases the cutaneous circulation, as evidenced by the flushed face and pleasant feeling of warmth. He thinks it may further be beneficial in adynamic conditions; chlorotic amenorrhœa, etc. For therapeutic purposes the dose would of course have to be smaller.

SKUNK PERFUME AS AN ANÆSTHETIC.

DR. W. B. CONWAY reports in the August number of the *Virginia Medical Monthly* a case where some roguish school boys caused one of their number to inhale from a two-ounce vial an unknown quantity of skunk perfume. The effects produced were total unconsciousness, muscular relaxation, a temperature of 94°, and pulse of 65, together with cool extremities. The respiration and pupils were normal. The patient soon recovered under the effect of hot pediluvia and stimulants. The skunk perfume is rather an unpleasant substance to experiment with, still those endowed with anosmia might obtain results of value from similar experiments with it.—*Chic. Med. Review.*

THE TAIL IN THE HUMAN EMBRYO.

THIS is a subject of considerable interest in view of the occasional statements regarding tailed races of men in the interior of Africa, and of the supposition that the human embryo has a tail homologous with that of the monkeys, and that, therefore, in this respect, man passes through a monkey stage, as insisted upon by Haeckel, who remarks, in his "History of Creation," vol. i., p. 308: "Now, man in the first months of development possesses a real tail as well as his nearest kindred, the tailless apes (orang-outang, chimpanzee, gorilla), and vertebrate animals in general. But, whereas, in most of them—for example the dog, it always grows longer, in man and in tailless mammals, at a certain period of development, it degenerates, and finally completely disappears. However, even in fully developed men, the remnant of the tail is seen in the three, four, or five tail vertebræ (vertebræ coccygæ) as an aborted or rudimentary organ, which forms the hinder or lower end of the vertebral column."

Now this notion is rudely disputed by Professor His, who contradicts in a paper on this question (abstracted in the Journal of the Royal Microscopical Society) the assertion that at a certain stage in its development the human embryo has a true tail, which is afterwards absorbed. As to the definition of a tail, Professor His considers that the caudiform or tail-like prolongation is a true tail when, extending beyond the cloaca, it contains a number, greater or less, of supernumerary vertebræ. Without this condition there is merely a caudiform appendage. His knows of no well-authenticated case of supernumerary vertebræ in the human embryo, and pathological observation he believes to coincide with embryological knowledge in justifying the assertion that in man the normal number of thirty-four vertebræ is never exceeded.

Prof. His's paper appeared in 1880; the same year, however, Dr. Leo Gerlach published in Gegenbaur's Morphologisches Jahrbuch (Band vi., Heft. i.) a paper on a case of tail-formation in a human embryo. He refers to a case of the occurrence of a tail in an abnormal embryo described in 1840 by Dr. Fleischman. On holding the fœtus up to the light there appeared, in the first third of the eight-lines-long tail, five dark points through the thin skin, which he regarded as vertebræ, the continuation of a spine. The end of this tail seemed to be skinny, and was very delicate and transparent. This embryo forms the subject of Gerlach's exhaustive anatomical account before us. The embryo is 10·8 centimeters (four inches) long, and was, in the early part of the fourth month, of embryonic life. The free portion of the tail is 12 mm. in length; it is long and slender, being in length equal to that of the foot of the embryo. In this tail a well-marked notochord is present. The organ, therefore, should be regarded as the homologue of a genuine tail, and Gerlach considers it as a case of atavism, and that it represents an earlier phylogenetic condition. He thinks, for reasons which he assigns, that at an earlier embryonic date there were a longer notochord, a longer medullary tube, and a greater number of primitive or proto-vertebræ. In an embryo a few weeks older, on the other hand, the notochord would entirely disappear. Haeckel's view, therefore, is, so far as one abnormal example is concerned, apparently sustained against that of His.—*American Naturalist.*

A NEW IMPORTED ENEMY TO CLOVER.

AGAIN we have to report the sudden appearance in this country of an insect which, though well known in Europe for almost a century, was never known to do any serious harm there to crops. We refer to *Phytonomus punctatus*, Fabr., a member of the Curculionid family, which every one who has traveled in Europe, and has paid any attention to insects, will doubtless have met with under stones, sticks, etc., in pastures and meadows. Mr. L. D. Snook, of Barrington, Yates Co., N. Y., sent us during the latter part of July a number of specimens of this beetle, with the statement that it greatly injures clover on his farm. Further particulars as to the nature of the damage have not yet been received. It is worthy of remark that this imported enemy to clover made its first appearance in the same county from which, three years ago, we first reported another European beetle affecting the same plant, viz., the clover root-borer (*Hylesinus trifolii*, Müll.).—*American Naturalist.*

HOW FERTILIZERS ARE MADE AT ATLANTA.

THE soil of the Southern States, with the exception of Mississippi, Louisiana, and Texas, and some parts of Florida, is not rich enough to grow cotton, tobacco, and grains luxuriantly without a constant return to it of the elements removed by the growth of those crops. The alluvial lands of Mississippi and Louisiana are stronger and more fertile than the sandy, red soils of the Carolinas, Georgia, and Alabama. On those rich bottoms artificial fertilizers are not yet required, though the process of cropping cannot even there go on forever without impoverishment any more than on the great wheat farms of the Northwest. One thousand pounds of cotton—fiber, seed, and stalk taken together—contain 28·6 pounds of phosphoric acid, 7·7 pounds of sulphuric acid, 35·1 pounds of lime, 22·3 pounds of magnesia, and 77·2 of potash. It is evident that the continued cropping of the soil must unfit it for cotton-growing unless these elements are returned to it in some form.

The earliest fertilizers used in the South were guanos from South America and superphosphates from Northern factories. The first commercial fertilizer ever made in the South was produced at Charleston, S. C., in 1868. Previously the phosphate rocks had been shipped to some extent to Philadelphia, Baltimore, or Connecticut to be made into fertilizers. In that year the Charleston Mining and Manufacturing Company began mining the rock, and another company established works for the manufacture of sulphuric acid, which had never before been manufactured south of Baltimore. Within half a dozen years more than $2,000,000 was invested in the manufacture of fertilizers at Charleston. That city is the natural center of the business.

It lies within 10 miles of the phosphate beds, and, in fact, its underlying strata are filled with the nodules of phosphate from which fertilizers are made.

These phosphate deposits are scattered over an area of more than 300 square miles. They crop out on the banks of the Ashley, Cooper, Stono, Edisto, Coosaw, and Combahee rivers, but are richest on the first named, where they pave the highway for many miles. The depth of the bed varies from 6 inches to 12 feet, and in some sections more than 2,000 tons to the acre may be found. The bed has been known as the "fish bed of the Charleston basin." Agassiz, Sir Charles Lyell, Prof. Toumey, and others were familiar with the deposits, on account of the large number of fossils they contained. The general character of the formation is that of nodules or conglomerates, of varying size, but on an average is hardly larger than a man's fist, bedded in blue clay and sand. It is thought to be of post-pliocene origin, though bones of man and fragments of pottery are found in the mass, having probably been added in comparatively recent times. Sharks' teeth, some of them of enormous size, weighing as much as two and a half pounds, and vertebræ and other bones of fish and of land animals, such as the mastodon, mammoth, megatharium, mylodon, horse, dog, and sheep, abound. The beds are, in fact, a vast antediluvian graveyard of animals and fishes of all kinds, and the phosphate nodules are the result of the disintegration of their bones.

To Dr. N. A. Pratt, a well-known practical chemist, and the director of the works of which I shall presently speak, belongs the credit of discovering how rich in phosphates these nodules are. Other chemists before him had, by crude analyses, fixed the amount of phosphate of lime they contained at from 9 to 15 per cent. While engaged in searching for niter for the Confederate Government he was led to suspect the richness of these beds, and by analyses in 1866 and subsequent years he discovered that from 50 to 70 per cent. of phosphate could be obtained from them—a proportion considerably higher than exists in the best Peruvian, Chilian, and Patagonian guano. These nodules are, in fact, bone phosphate, the best possible material for the basis of a fertilizer. "These phosphates are strictly of animal origin, and consist essentially of bones," says Dr. Pratt. To make them available as fertilizers it is only necessary to treat them with sulphuric acid, by which a sulphate of lime (land plaster) is formed, and the phosphate, robbed of a part of its lime, is left in a soluble form.

The works of the Georgia Chemical and Mining Company are the first in this country to make sulphuric acid from iron pyrites. At the Charleston works the acid is made from sulphur obtained from Sicily, where it is made from volcanic rocks, and costing now about $35 a ton. The first cargo of sulphur sent to Charleston, in 1868, cost $64 a ton in gold—about $104 in currency. In 1871 Congress removed the duty of $13 per ton, and the price fell to $45. Sulphur is subject to fluctuation in price sufficient in extent and frequency to seriously interfere with the profits of the business of fertilizer works compelled to rely on the foreign supply. The Georgia works are independent in this respect. They obtain a supply of pyrites from Harrison County, where it is dug up in a mine 150 feet deep. The company has contracted for six years with Mr. William Tudor, of Boston, a chemist, and Mr. Frederick L. Hart, of Montreal, a practical miner, to furnish a supply of pyrites. The ore is hauled by mules 12 miles over a mountain, and then shipped by rail 70 miles to the works, which are situated about two miles from Atlanta, on the Georgia Railroad.

The most important operation is the making of the sulphuric acid from the pyrites. Half a million tons of pyrites are annually burned in England, and the furnaces at the works here are built on the English model, though with some modifications devised by Dr. Pratt. The works are not yet complete, but the furnaces and great leaden chamber for containing the acid are finished, and from Dr. Pratt I got a clear explanation of their manner of working. There are 20 of the furnaces arranged in a battery. These furnaces having been heated with coke, the pyrites is thrown in just as it comes from the mines, and speedily ignites. The beauty of this roasting is that the pyrites supplies in itself the combustible material, and no coal is necessary. Once started, the fires are never allowed to go out. In the combustion of the pyrites sulphurous acid gas is given off, and passes through a large tube into a vast chamber, whose walls are of sheet lead supported by timbers. Sulphurous acid, which is the pungent vapor given off when a match is lighted, consists of one part of sulphur and two of oxygen, a compound of which the chemical symbol is SO_2. Sulphuric acid has three parts of oxygen to one of sulphur—that is SO_3. The addition of the required equivalent of oxygen is accomplished in the leaden chamber. With the sulphurous acid there is included nitric acid vapor, evolved from the nitrate of soda. With these two acids atmospheric air and steam are also admitted. In this happy family remarkable changes take place. The nitric acid gives off a part of its oxygen to the sulphurous acid, making it sulphuric acid—SO_3. This acid, a solid when pure and undiluted, is liquefied by the steam, and falls to the bottom of the chamber. The nitric acid then borrows from the atmosphere more oxygen, which it immediately gives up again to the sulphurous acid. Thus the process goes on indefinitely, the nitric acid serving merely as a vehicle for the oxygen, which cannot be transferred directly from the air to the sulphurous acid. The gases introduced from the furnaces pass throug a distance of more than 300 feet in the leaden chamber, and finally through a Guy Lussac absorption tower, in which very strong sulphuric acid is allowed to percolate through lumps of coke, until, when every particle of sulphur has been squeezed out of them, and combined with oxygen, a single element, nitrogen, remains, and as this is of no value it is allowed to escape. The sulphuric acid, which does not act on lead, remains in the bottom of the chamber until drawn off.

The union of the sulphuric acid and the phosphate rock takes place at these works in a novel manner, the process being an invention of Dr. Pratt. In the South Carolina mills and those at Augusta the rock is first dried, then run through the crusher, and finally ground to a powder in burrstone mills. It is then carried to a cast-iron tank, some eight feet in diameter, which revolves twenty times a minute, and in which are small plows revolving in the other direction at the rate of 160 times a minute. The sulphuric acid is run into this revolving tank, and combines with the ground prosphate. The mixture falls in a pasty or semi-fluid mass into a box below. Dr. Pratt reduces the various stages of this process to two—crushing and grinding. He sends the rock to the crusher wet or dry as it happens to be. It is there reduced to fragments of a uniform size and sent to the burr-stone mill, into which the sulphuric acid is admitted while the grinding is going on. The acid attacks the outer surface of each lump of rock and softens it, so that the particles are easily removed by the stones. A new surface is thus exposed, which is at once attacked by the acid, and so the process goes on until the lump is worn away. By the old process a single run of stones would grind two and one-half tons of rock per day. By Dr. Pratt's method one run of stones grinds eight tons per day with far less handling. The mixture—phosphate and sulphate of lime—which is formed in the mill, falls into a car below, and is removed in a state resembling mortar and allowed to dry in sheets. When dry it is easily pulverized, and is ready for use. It is then called acid phosphate or superphosphate, and is either applied directly to the land or is mixed with ammonia, potash, or animal matters, when it becomes the true commercial fertilizer. The Georgia works will make no fertilizer—only sulphuric acid and acid phosphate. There are fertilizer works each side of them which will employ nearly their entire product. The works will consume 3,000 tons of iron pyrites and 6,000 of phosphate rock per annum, and will produce 50,000 pounds of sulphuric acid every day. The amount of acid phosphate produced will be regulated by the demand. The sulphuric acid is worth from $25 to $30 a ton. Another source of profit will be the copper contained in the pyrites. Dr. Pratt estimates this at from 3 to 5 per cent., that is, from 60 to 100 pounds per ton of the ore. At 15 cents a pound this would bring in $9 a ton, on the basis of the smaller estimate, and this, I suspect, would nearly pay for the crude pyrites, giving the company the sulphur obtained from it free of cost. The residuum remaining in the process after the sulphurous acid is drawn off will be treated for the extraction of the copper. This process will leave another residuum, an iron ore of a very high grade. Out of the 3,000 tons of pyrites consumed in a year Dr. Pratt estimates that 1,500 tons of iron may be obtained. The economy of the process may be seen at a glance. One ton of pyrites is to be made to yield, say 900 pounds of sulphuric acid, worth about $12, $9 worth of copper, and 1,000 pounds of iron. There is certainly very little waste in that, though it is not probable that the iron will be smelted by the company.

The works have been built at an expense of from $75,000 to $100,000, with Cincinnati capital. The company was formed under a charter obtained by Dr. Pratt, with a capital of $200,000. Its president is Mr. Otto Laist, of Hartmann, Laist & Co., of Cincinnati. Benjamin Eggleston, president of the Second National Bank of Cincinnati, is its treasurer; Deacon Richard Smith, of the Cincinnati *Gazette*, is one of its directors and principal shareholders; and Dr. H. A. Pratt is its managing director. The enterprise will be of great benefit to Georgia and the South, because it makes use of and develops one of the resources of the State, iron pyrites, which has hitherto lain dormant. Ultimately the use of this ore for making sulphuric acid, and the use of the improved processes I have described, will cheapen commercial fertilizers. At present, of course, the company will maintain its goods at the market rates, but unless I am greatly mistaken the profitableness of this branch of manufactures, as conducted by them, will invite competition and bring about a reduction in price which will greatly extend the use of fertilizers and increase the profits of farming. At the present price of commercial fertilizers—$36 a ton—the enrichment of the soil is too high a tax upon the price of the crop. Using 200 pounds, costing $3.60 to the acre, and raising thereon, say, 350 pounds of cotton at 10 cents per pound, the farmer pays, it will be seen, a little above 10 per cent. of the value of his crop for fertilizers, and under the credit system every ton of fertilizer costs a bale of cotton, which is still worse—about 14 per cent. The importance of cheapening the article and extending its use cannot be overestimated. The profitableness of farming in the South depends upon it.—*C. R. M., in N. Y. Times.*

[NORTHWESTERN LUMBERMAN.]

NATURAL AND INDUSTRIAL HISTORY OF THE WHITE PINE IN MICHIGAN.

THE following interesting paper was read by Mr. William Hosea Ballou, of Evanston, Ill., before the American Association for the Advancement of Science, at Cincinnati, August, 1881.

Forty-six years ago, the pine lumber industry of Michigan had its origin on the banks of the Saginaw River. From that time to the present, the denudation of timber has increased in that State and other pine areas to such an extent that, within the next decade, the use of such material as a commercial product must pass out of existence, unless preventive steps are taken. Already the producer is beginning to look with genuine alarm for such aid as science may extend to avert a calamity which certainly threatens an industry, the capital invested in which would have paid the expenses of the late civil war. It therefore devolves upon us to discuss not only the enemies of the pine tree which nature herself has inaugurated, but also the statistics of the destruction by the more formidable consumer, man. This paper is necessarily confined to the white pine as it was, and to-day is, in the State of Michigan.

The first thought suggested is relative to the origin of the white pine forests. From whence comes the species

which so strictly confines itself to its own peculiar territory? The oak, and most other trees, are naturally reproductive, and young trees are equally prolific in their growth on the soil where the first forest was leveled to the ground. They may be transplanted on almost any territory, and without any special care, and speedily grow up to a state of usefulness to man. Not so with white pine. It is now an almost undisputed fact that it will not reproduce itself on the parent soil. When transplanted elsewhere, its development is marked with early decay in so many instances as to disparage the work. Furthermore, it is beset at once with the same host of enemies common to it on its indigenous soil.

For some years past my attention has been directed to facts which may have bearing on the question under consideration. The pine of the level country east of the Rocky Mountains seems to have its best growth in proximity to the lake region. I have noticed that frequently where a lake recedes, leaving a sandy beach, evergreens, the juniper pines, etc., are very apt to spring up. Within the memory of man, a wide sand-beach near Waukegan, on Lake Michigan, has been formed, and on this area a miniature white pine forest has appeared, and thrives. On some lone islands in Lake Erie, of evident recent formation, called the "East Sister," the "Old Hen," etc., I observed, several years since, a similar phenomenon had occurred. These, and other facts, point to a recent origin of the pine forests under consideration, which may not have been in existence at the time of the landing of Columbus. This fact is more apparent when it is stated that the average age of the pine is less than 300 years, in this country, and the other fact is reiterated that it does not reproduce on the same soil. The present forests, then, must have been the natural successors to some other species which had exhausted that vitality of the soil necessary to their existence. Such phenomena are so familiar to naturalists that further elaboration is unnecessary. It matters not whether the seeds were blown there by the winds, or lay dormant in the soil until their turn, or, indeed, what the speculation concerning them is, so long as the facts are inaccessible; certain it is that the origin of the pine forests in Michigan is a matter of several centuries ago.

The next question of importance is reproduction. Answers to queries submitted to over one hundred practical lumber men, as well as careful observation, make positive the fact that the reproduction of the white pine on parent soil is impossible as a commercial success. So far as the pine is concerned, the most important fact has relation to the exhaustion of that vitality of the soil necessary to this species. Other causes have been advanced, to the neglect of this, which plainly do not bear on the subject. Were reproduction successful—and here is the great practical proof of the matter—my one hundred informants say that, long ago, forests would have been cultivated to replace those now a fact of the past.

The enemies of the white pine are numerous. The average of the data I have gathered tends to show that the pine forests began to decay before one-half of the trees were matured. The causes of such decay are the growth of "punk," or rot, "wind-shakes," and "loose knots." Insects do not originate, but hasten decay, as will be shown. The punk is a rot, sometimes a foot in diameter, which appears in a lump on the side of the tree, eating into its vitals. It is due to more than one cause. Opinions of writers vary on this subject, all of whom argue in behalf of a special cause. I have carefully examined all of these claims, but am convinced, from extended observation, that anything which affects the vitality of a tree will produce punk. It matters not whether the tree becomes wind-shaken, or the soil exhausts, or a knot penetrates to the heart, or what befalls it when alive, punk is sure to become the secondary condition, followed by destruction.

Enemy number two is the black knot. This is a loose knot, black in color, which, when the tree is sawed, drops out of the board, making it defective. It is caused by imperfect growth. If there is not sufficient nourishment at the roots to support the limb, it grows imperfectly, and its inner termination works toward the heart, as if to suck sap from the vitals. This brings on loose layers, and subsequent decay.

A wind-shake is one of the most exasperating defects of lumber. It is noticeable in a board the layers of which separate, or split, in a triangular form when the sawing takes place. It occurs, generally, on the butt of the tree, and is caused by the force of the wind when the tree is standing, and by frost when the log rests in the mill yard. Opinions vary on this latter point.

There are other enemies of the pine, all of which deserve attention just at this time, when commerce must begin to economize, and obviate, so far as possible, all difficulties in the way of making the product supply the demand.

The first of these is fire. All parties agree that from one-third to one-half of the timber product is destroyed by this agent. Fires, where they occur, follow clearings, but often penetrate the dense forests, sometimes covering an area of 100 square miles. It is impossible to secure data on this subject, because more or less lumber is saved from the wreck. A pine tree that has been scorched is utilized the succeeding year, or the worms destroy it.

Insects are very destructive, the pine weevil, *Tomicus xylographus*,* being a foremost agent. These attack a sound tree, but not a live one. If any one will take the trouble to enter a great log yard at dusk, these creatures will be heard at work, the united sound of which is like the roar of wind or water. The grub goes through a log in a crooked line, leaving a passage way which greatly depreciates the value of the timber.

There is a pin worm, the scientific name of which has escaped me, that bores its way straight to the heart, leaving a round, black passage the size of a pin-head. These are the only insects which lumbermen take into account in Michigan, I believe.

The white pine does not furnish so rich a pitch as the yellow pine of the South. It has but little market value. It is sometimes gathered for medicinal purposes, melted, cut with spirits, and used for throat diseases. Some people use it for ague, but so much whisky is mixed with it that the scientist pauses on the threshold of doubt as to whether the pitch is used to save the whisky, or the liquid to get the benefit of the pitch.

A pine tree grows from 90 to 160 feet in height, the average being 125 feet. A log sixteen feet long will average 250 feet of lumber, though one log has been known to produce 2,300 feet. The diameter of an average log is 30 inches; the maximum is 6 feet. A pine tree begins to branch two-thirds of the way to the top, often branching at the top only.

The facts give rise to a general formula, that a tree is no greater than its roots. The expanse surface of roots of the pine correspond closely to that of its height and outer surface. Although much crowded in a dense forest, the roots of an overturned tree have been known to yield a surface of forty feet square, 1,600 square feet. Pines grow usually on high ground, in sandy soil, but best when the latter is mixed with clay.

The waste branches of the pine tree are not utilized to any extent except as fuel. Pine sawdust is now converted into paper pulp extensively, and is used in packing glass-ware, and in other ways as a commodity.

The heart of the pine resists to the last all injurious causes which operate on the outer layers. Windfalls are severe agents of destruction, as speedy decay follows.

The following items are relative to the pine lumber industries of Michigan. I am largely the debtor of Mr. G. W. Hotchkiss, secretary of the Lumberman's Exchange, Chicago, to the files of the *Northwestern Lumberman*, Mr. J. W. Longyear, of Marquette, E. D. Galloway, Howell, Mich., and others, for the information here given.

In 1835 there were 150,000,000,000 feet of pine timber on 20,000,000 acres of land. Since that time 115,000,000,000 feet have been cut. In the northern peninsula there now stand 6,000,000,000 feet of timber on 4,000,000 acres. On the southern peninsula are 29,000,000,000 feet on 6,571,000 acres. This leaves a total of 35,000,000,000 feet on 10,571,000 acres. Some 5,000,000,000 feet are now annually taken, so that in seven years the supply will be exhausted.

In this industry (which, of course, must include lumber of all kinds) there are in 600 mills, 150 gang saws, 600 circular saws, 100 mulays, and 500 edgers, with a total capacity of 5,000,000,000 feet per annum, and a total value of $11,750,000. There are 800 vessels engaged in the transportation of this lumber, occupying 4,800 men, and valued at $4,000,000. In the woods in winter are 50,000 men at work, and 20,000 in the saw mills in summer. There are 30,000 animals thus engaged, one-third of which are oxen, and the remainder horses. There is a total of 75,000 men and animals; a total capital invested in mills of $111,750,000. The lumber taken from the forests since 1835 has sold for about $1,500,000,000.

The ancient lower limit of the white pine belt extended from Grand Haven to Port Huron, dipping on the west side of the State to Kalamazoo. The whole pine area now comprises 288 townships in 18 counties in the lower peninsula, embracing 10,268 square miles, or 6,571,520 acres; and in the upper peninsula, 179 townships, or 4,124,160 acres.

It almost seems like a task of despair to hope to ever raise forests for another such enormous production. Science will doubtless devise other materials as a substitute. Indeed, I have been shown a material manufactured in the West, in the shape of a board one inch thick, made from wheat straw, which can be colored to represent any lumber now known so accurately as to deceive the eye. The inventor manufactures 2,000 square feet from a ton of straw. It is more durable and much cheaper than lumber. As a parallel to the use of paper wheels, Mr. Pullman is now said to be finishing off three palace cars in this material. The limit of its manufacture will depend only on the production of wheat straw.

* An entomologist of the Association believed this to be some other species.

FINDING THE LATITUDE OF A PLACE BY THE STARS.

"AMONG all the means employed by travelers of ascertaining the latitude of a place of halt, there are few," writes M. Adan in a recent paper to the Belgian Academy, "which do not involve conditions, easy to be fulfilled in observatories, but nearly always troublesome, or even impossible, during a journey.

"It would be a great advantage if the explorer had not to await the meridian passage of a known star, or make correspondent observations, the second of which is often missed by reason of the state of the sky; if, again, he had not to determine the local hour or the azimuth of a star, when the time passed at a halting-place required him to take observations on only one side of the meridian.

"Thus, it has long been common to commend the process of extra-meridional zenith distances, either of two stars, or of the same star, at instants, the interval of which, given by a pocket chronometer, is translated into sidereal time, and converted into arc. A doubtful observation may be recommenced a few minutes later, and the traveler will very soon have the latitude in any case.

"Still, this method has never, so far as I know, been employed, probably because of the complication of trigonometrical formulæ not calculable directly by logarithms, to which it is necessary to have recourse. Perhaps it is for this reason that travelers do not bring back from their long journeys the geographical co-ordinates of the places visited, and leave their routes doubtful. It would suffice, however, to know a few points with an approximation of one to two sexagesimal minutes, to be able to draw these routes on maps as exactly as the scale adopted in production of such documents would allow.

"Now it is possible to obtain the latitude by a graphic process with a precision which is greater, the more care has been taken in constructing the stereographic projection of the celestial sphere, and the more distant from the zenith the stars observed, without, however, exceeding the limit of distances where refraction does not produce inconstant effects.

"At any moment the geometrical position of the zeniths of all points of the earth whence one sees a star at the same zenith distance is a circumference of a circle in a plane perpendicular to the line joining the earth and the star. The radius of this circle is equal to the sine of the zenith distance.

"The respective positions of the stars observed may be easily indicated on the projection; the precision will depend on the dimensions of the map and the exactness of its drawing. Then, by a simple and easy construction, one may obtain perspectives of the two geometrical positions which will be indicated by circumferences on the planisphere of Hipparchus.

"The scale and compass, then, suffice for the solution of the problem before us; the traveler will have no occasion to trouble himself with ephemerides, trigonometric formulæ, or logarithms, and, especially, he will not have to await the end of his exploration before being able to reduce or work out his results. One of the points of intersection of the two circumferences is the projection of the zenith of the place of observation. The latitude will then be given by the map on the circle of contour of the projection.

"The stereographic polar projection seems the best to employ in most cases; the celestial meridians are straight lines converging to the center; the parallels are concentric circumferences whose radii cross like the tangents of polar demi-distances. It would, however, be advantageous, if one wished always to observe the same bright star, to place this star in the center of the projection; the first geometrical position would be constantly one of the circumferences, having for center the projection of the star itself, and it would merely be necessary to construct the second circle by geometrical means.

"If the traveler were in any way deprived of the instrument suited for measurement of zenith distances, he might draw on the stereographic projection two verticals, in which are found, at instants whose interval is known by the chronometer, couples of catalogued stars previously brought on the projection, provided he does not possess ephemerides, which will enable him to choose the most favorable stars for the instant when he is at leisure to make observations.

"If, lastly, the traveler take care to show on the map, in relation to stars observed at the first halting-place, the positions of those whose zenith distances he will take at each halt in his journey, he will thus obtain the relative situations of zeniths of the places traversed, and from the map he will approximately know the longitudes, if, at least, his watch be worthy of a certain confidence."

M. Adan furnishes, in a list (*Bulletin* of the Belgian Academy, No. 8), a certain number of couples of stars, the choice of which is to be recommended, with reference to the precision of the graphic results to which their observation will lead. The conditions are the most favorable when the stars are distant from each other, and the circumferences representing the geometrical positions of the zenith intersect at angles comprised between 60° and 120°. The stars should be 15° at least from the horizon, and, if the sextant be used, removed from the zenith more than 30°. The star whose zenith distance reaches this limit or is under it, will suit if the traveler have a reflection circle or a portable theodolite.

THE ANCIENT PALACES OF UXMAL, MEXICO.

AMONG the interesting exhibits contributed to the recent American Archæological Exhibition, at Madrid, were a series of photographs, furnished by the distinguished and indefatigable explorer, Dr. Augustus de Plongeon, taken from the ancient palaces near Merida, State of Yucatan, Mexico. These remarkable remains have for many years been studied by archæologists, but no really satisfactory conclusion has been reached in respect to their origin or purposes. From some of the photographs above mentioned, our excellent contemporary, *La Ilustracion Española*, of Madrid, has made engravings, which we present opposite. When or in what epoch were these wonderful structures built? Dr. De Plongeon's theory is that they were contemporaneous with the existence of the mastodon—a theory that is based on the fact that the head of this now extinct animal appears as a forced element in all the ornamentations of the principal façades of the edifices. On the same basis the theory is also advanced, that divine qualities were attributed to this animal by the ancient Mexicans as they were to the elephant in Hindostan.

The governor's house, illustrated in our engravings, is a grand ruin. It has a front of 322 feet. The palace of the nuns, besides a large courtyard, had eighty-eight apartments. These extraordinary remains show that a former race, possessing high civilization, once peopled the country. That they must have been a rich, powerful, and industrious nation, having many great cities, is also attested by most extensive series of masonry works that have been in part uncovered.

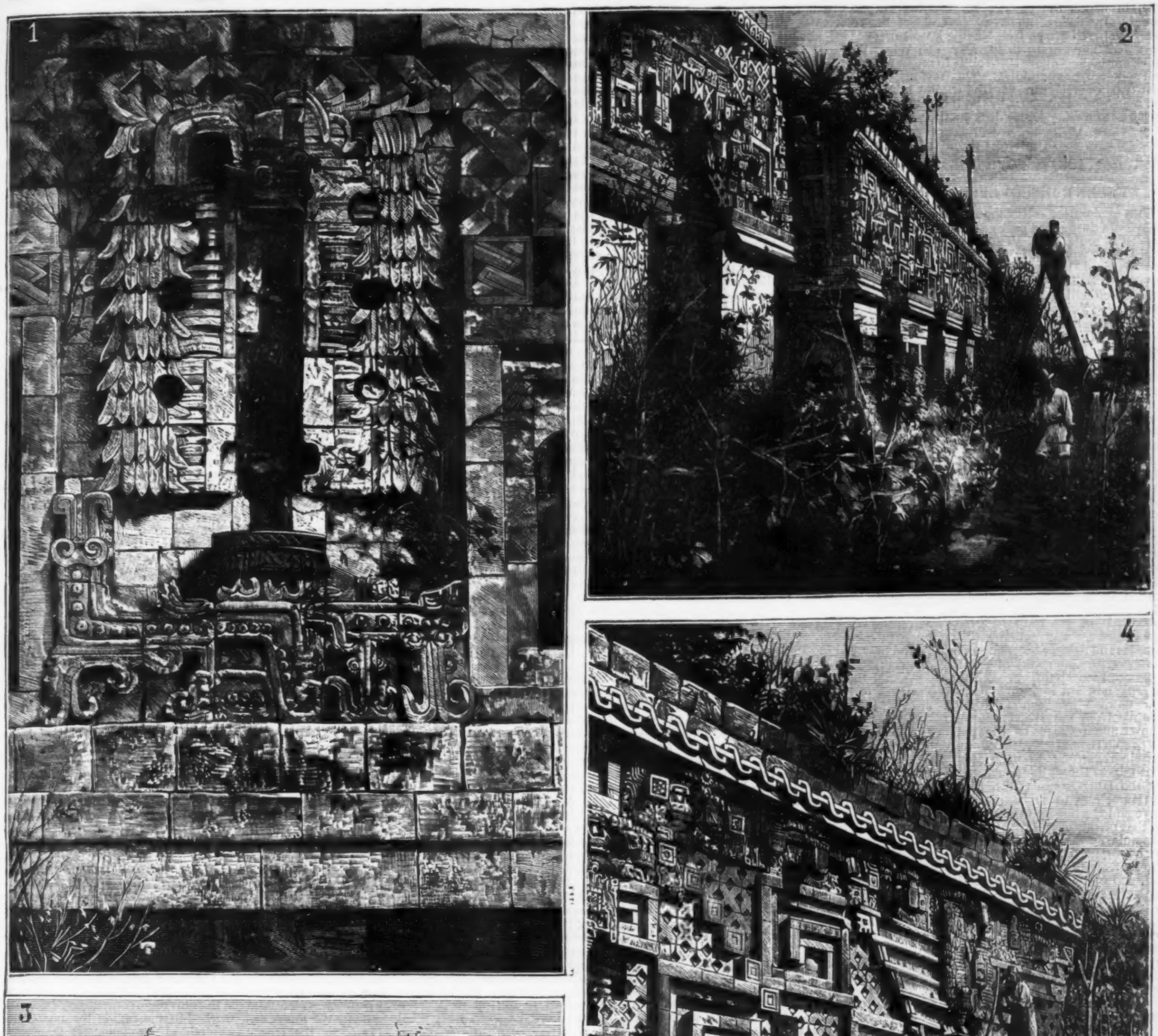
Mr. Marshall P. Wilder, at the annual meeting of the New England Historic Genealogical Society, held in Boston, Jan. 4, 1882, read the following private letter, which he had received from Dr. Augustus de Plongeon, the Yucatan explorer above mentioned:

"I have discovered among the ruins of Mayapan the gnomon used by the astronomers of that city; also a complete Masonic temple with symbols and hieroglyphics. I have found the portraits of founders of cities, and interpreted the meaning of certain ornaments that have been misunderstood by other travelers. I have ascertained that the key to the ancient Maya alphabet is the true one, and by its means Mrs. De Plongeon and myself have been able to read the names of the founders and those of the cities. I have found that this alphabet contains letters and characters belonging to the Egyptian, Etruscan, and Chaldean alphabets, and also that the Maya language is akin to all the ancient languages spoken by men in ages long gone by. My studies have caused me to believe that the founders of the first Chaldean Monarchy were Maya, and probably the people who colonized Egypt and brought civilization to that country. You must remember that the Egyptian priests always pointed to the West when asked concerning the birthplace of their ancestry."

In regard to the existence of the mastodon on this continent, we publish in another column of this SUPPLEMENT the interesting observations of Prof. Collett, showing from various specimens of remains found that no very great period has elapsed since the last of these creatures disappeared.

TEXAS PAINTED CAVES.

MR. J. VAN WIE informs the reporter that his grading forces on the Mexican extension of the Sunset railway are now at Painted Cave, on Devil's River, or about two miles beyond. The work east of that point is very rough, but Mr. Van Wie has comparatively easy work for about a half mile west. There are three caves at this locality, all of which are painted, the figures being buffaloes, bears, Indians with bows and arrows in warlike attitudes, Indians mounted and on the chase, squaws, etc. The caves have been tattooed entirely within, and many of these figures are in a good state of preservation. This work was done by the red men in years long gone by, as the oldest white citizens remember these paintings, and say they look very much now as they appeared thirty and forty years ago, indicating the great age of the paintings. Mr. Van Wie has occupied one of these caves for kitchen and dining-room purposes. It is about forty feet long and ten feet wide. It is approached by climbing a hill, when the cave is entered from the side of the hill. Its mouth is covered by clusters of vines pendent from the branches and boughs of a clump of hackberry trees. In the top of the cave is a hole, extending to the surface, through which Mr. Van Wie has run two stove pipes. Another cave still, its shape being round, and of capacity to hold seventy or eighty people, is used for storage purposes. The third cave opens in a solid rock bluff, being about six feet in diameter at the mouth, and extends backward a distance of about 150 feet. This cave is to be used as a maga-



1. NICHE IN WHICH WAS FOUND THE STATUE OF KINICH-KALHUIO, WIFE OF CHAACMAL (FACADE OF THE GOVERNOR'S HOUSE, UXMAL.)—2. FACADE OF THE GOVERNOR'S HOUSE, UXMAL.—3. WING OF THE PALACE OF THE NUNS.—4. PRINCIPAL ENTRANCE TO GOVERNOR'S HOUSE, UXMAL.—(Archeological Antiquities, Mexico.)

zine, in which the powder for blasting purposes will be stored. Just below the caves, the cliffs of the rock extend from twelve to fifteen feet, leaving a vacant space of about forty feet underneath them. Mr. Van Wie will locate his blacksmith shop under these cliffs to repair and sharpen tools and shoe horses and mules. This region, until within the past two or three years, was the wildest in the State, and the red man was its inhabitant. So it had been for all time past, so far as known. And this is another remarkable instance of how we Americans are progressing, even pushing our greatest agencies of progress through the very Gibraltar of the savage.—*San Antonio Express.*

RECENT DISCOVERIES IN BABYLONIA.

THE exploration of the mounds and ruins of Assyria and Babylonia during the past year and a half has yielded a rich harvest of antiquities. The London *Times*, speaking especially of the work of Mr. Hormuzd Rassam, says that though they have not afforded us such "great finds" as the bronze gates from Ballawat, have, nevertheless, been rich in discoveries which will be welcomed by all students of history and philology. The recovery of the library of terra-cotta tablets from the palaces of Sennacherib and Assurbanipal has restored to us a vast mass of literature and supplied long lost chapters in the history, mythology, and science of the world. It has also proved to us that, valuable as these records are, we have in them but second and third editions of works first compiled by the scribes in the library cities of Babylonia. The discovery of fragments led Assyriologists to hope that the explorer would be able to recover from the ruins of the cities of Chaldea the older versions of the Assyrian texts, and the expedition of 1880–81, which Mr. Rassam has just concluded, has so far met their wishes in that from the ruins of the temples and palaces of Babylon, Borsippa, Sippra, and Cutha he brings records and copies of religious texts, some of which will, no doubt, furnish the required Chaldean versions.

From the earliest days of Mesopotamian travel the spade of the explorer has been applied to the ruins of Babylon. Strange as it may seem, although for more than three centuries the ruins have been known and visited, and for centuries the Arab brick merchants have been digging amid its ruins for bricks, it is only within the last few years that records of importance have been recovered. With the exception of thousands of bricks bearing the names and titles of Nebuchadnezzar, and cylinders inscribed with the records of temples and palaces built or restored by the builder-king and his successors, no record of historical or scientific importance has been recovered from amid the ruins. But the year 1874 began a new era in Babylonian explorations, for from that time on there has been a continuous flow of inscriptions and records from the treasure-house of the city; and we now know much more of the popular life of Babylon and its people than after years of study we have been able to ascertain regarding Nineveh from monuments and records. The tablets found by the Arabs in 1874–75 were purchased by the late George Smith for the trustees of the British Museum, and the subsequent finds made by Mr. Rassam have added some hundreds to this branch of the collection, so that of this class of tablets there are now more than 3,000 examples in the British Museum. These tablets show that for a long period, probably several centuries, the family of the Beni Egibi were the leading commercial firm of Babylon, and to them was confided all the business of the Babylonian Ministry of Finance. The building whose ruins are marked by the mound of Jumjuma was the *chancellerie* of the firm, and from its ruins come the records of every class of monetary transactions. The documents being all most carefully dated and compiled, are of great value to the chronologist and historian; while to the student of Babylonian civilization they are of the highest importance. From the tax receipts we learn how the revenue was raised by duties levied on land, on crops of dates and corn, on cattle, by imposts for the use of the irrigation canals and the use of the public roads. It is almost impossible to estimate too highly the importance of such a series of documents as these, dealing with every phase of social life, and coming to us from a city from within whose walls were gathered representatives of every "nation, people, and tongue."

The inscriptions which Mr. Rassam has recovered are not confined to documents of this class only. It was long feared by Assyriologists that Babylonian history was irretrievably lost, as no historical records were recovered, but from the ruins of the palaces of the Kings of Babylon Mr. Rassam has brought fragments of historical inscriptions of Nebuchadnezzar, a valuable *précis* of the history of the last days of the Babylonian Empire, extending from the seventh year of Nabonidus to the fall of the city before the hosts of Cyrus, a royal record of the Persian conqueror, and lastly, an inscribed record of the last great victor who entered Babylon, Alexander of Macedon. The scarcity of stone in Babylonia, and the extensive use of bricks, rendered the ruins of Babylonian palaces not fruitful fields for the explorer in search of architectural remains. In the ruins of the Kasr or "palace" mound, Mr. Rassam has found chambers and corridors which formed part of the royal residence of the Kings of Babylon. The use of plaster and painted bricks as decoration in these chambers affords strong support to the statements of the Greek writers as to the mode of decorating the royal residences of Babylon. On the extreme north of the ruins of Babylon, and partly without the *enceinte*, is the large mound called by the natives the Babel mound. Excavations made here have brought to light the remains of extensive hydraulic works, wells, and conduits lined with stones, and evidently connected with the Euphrates. The discovery of these remains would seem to indicate that here had stood the hanging gardens, built by the Babylonian King for his Median Queen, and the supposition receives additional support from the recovery of a small inscribed tablet, which clearly proves the fondness of the Babylonian Kings for horticulture. A scribe attached to one of the palace or temple libraries of Babylonia has transmitted to us a list of the gardens or paradises of the Babylonian monarch, Merodachbaladan, the contemporary of Sargon, Sennacherib, and Hezekiah. This monarch appears to have been a lavish patron of horticulture, for the list furnishes the names of more than 60 gardens and parks in and about Babylon constructed by the royal order.

Leaving Babylon, we now cross the Euphrates and pass southwest to glance at the work which has been carried out on the ruins of the Birs Nimroud, the traditional site of the Tower of Babel, but really the ruins of the seven-staged Ziggurat, or observatory tower of the great temple of Nebo at Borsippa. Excavations in the Birs have brought to light several chambers of the ancient temple, and also afforded much information regarding the construction of the stage tower. From this site Mr. Rassam has brought some fragments from the great mass of vitrified bricks, which has so long been a puzzle to travelers, and it is to be hoped that some student of science may explain the cause of this vitrifaction. Babylon may claim to be the mother of Nineveh and the cities of Assyria, yet among the cities of its own land there were those which could lay claim to far more ancient traditions, and even to being the ancestors of Babylon itself. All students of history and antiquity will welcome the discovery made by Mr. Rassam of the sites of two of these ancient cities, whose records and traditions carry us far back to the days when, perchance, Babylon was as yet "a little village." While in the neighborhood of Bagdad, Mr. Rassam heard from the Arabs of some ruins, on the banks of a half-dry canal, called by the Arabs Yusuffieh, where plenty of "written stones were to be found." The mounds to which his attention was directed were called Deyr, and were situated on the north bank of the canal, about 30 miles south-west of Bagdad. The test trenches cut in the mounds did not bring to light any very important remains, only a number of inscribed bricks of the time of Nebuchadnezzar, and no information was afforded as to the site represented by the ruins. But if the mounds of Deyr were drawn blank, a more fruitful spot was awaiting the touch of the explorer's wand to burst forth into a rich harvest of discoveries. While working at Deyr Mr. Rassam paid a visit to the mounds called by the Arabs Tell Abu Hubba, where his test trenches soon rewarded him for the disappointment of Deyr. The mounds of Abu Hubba are very extensive, covering an area over two miles in circumference, and the position of the walls and citadel are clearly marked by mounds and embankments of *débris*. Like most Babylonian edifices, the buildings at Abu Hubba are built with the angles to the cardinal points.

The citadel occupies the southern portion of the *enceinte*, and its highest point was on the southwest face, which was once on the banks of a broad canal or a branch of the Euphrates, the bed of which is now represented by the dry channel of the Ruthwaniyeh Canal. In the interior of the edifice an interesting pair of rooms were discovered and cleared of *débris* by the fortunate explorer, and it is from records found in these chambers that we have been able to ascertain the name of the city and the nature of the edifice whose ruins are buried beneath the mounds of Abu Hubba. In excavating a trench, following a wall in the central portion of the mound, a doorway was found leading into a large gallery or chamber 100 feet in length and about 35 feet in width. In this chamber were the remains of a large brick altar nearly 30 feet square, and evidently the great sacrificial altar of the temple. In the wall of this chamber a door was found leading into a smaller room, which from its construction and position, Mr. Rassam considered to be the record chamber of the edifice. In his explorations at Ballawat, which we fully described some time since, Mr. Rassam found the memorial records of the builder of the great temple of the Assyrian war god placed in a stone cist and buried near the altar. The scarcity of stone in Babylonia caused the builders of the temples at Abu Hubba to inclose the records in a cist made of terra-cotta and to bury this beneath the floor of the chamber. The shaft sunk by the excavators employed by Mr. Rassam brought these precious records to light, and from them we are able to ascertain the name of the city and temple whose ruins have been discovered. The first three lines of the largest of the foundation records bring our speculative thoughts to a focus and center our minds on the traditions of one of the most ancient cities of Chaldea: "To the Sun-god, the great lord, dwelling in Bit-Parra, which is within the city of Sippara." Here, then, we have restored to us the ruins and records of a city whose traditions go back to the days before the Flood, when pious Xisuthrus, by order of his god, "buried in the city of Sippara of the Sun the history of the beginning, progress, and end of all things" antediluvian. And now we recover, 27 centuries after they were buried, the records of the pious restorers of this ancient temple. Such a discovery as this almost makes us inclined to dig on in hopes of finding the most ancient records buried there by the Chaldean Noah.

There are many points of history raised by this inscription, but it will suffice to say that from the earliest days of Babylonian history the city of "Sippara of the Sun" was a prominent center of social and religious life. The excavations, therefore, at Abu Hubba have restored to us the ruins of the great temple of the sun-god, "the House of Light," in the Chaldean Heliopolis. The monuments reveal to us the fact that there was a second city of Sippara, whose ruins are probably marked by the mounds of Deyr, and which was dedicated to the goddess Anat or Anunit, and the two cities of Sippara may be identified with the cities of Sepharvaim, mentioned by the Hebrew writer of the Second Book of Kings. This discovery is greatly enhanced by the further discoveries made by Mr. Rassam in another grave mound of Chaldea. The excavations which the explorer made in the mounds of Hubl Ibraheem, some 10 miles east of Babylon, have restored records which prove that beneath these ruins were the remains of the temples and palaces of the city of Cutha, one of the great theological centers of Babylonia. In the southern portion of the larger of the two mounds at Hubl Ibraheem, Mr. Rassam found extensive remains of buildings, chambers, and corridors, and the inscribed bricks and tablets recovered point to these edifices as being the remains of the great Temple of Nergal and his consort Laz, which was restored by the great temple builder Nebuchadnezzar. To the Biblical scholar the discoveries of these cities, Sepharvaim and Cutha, is a great gain, for from them were brought the men of Sepharvaim and the men of Cutha, who were placed in Samaria by the Assyrian conqueror, Sargon (2 Kings xvii.,24–31). The descendants of these worshipers of Adrammelech and Anammelech, and Nergal, the god of Cutha, are now to be found in the small white robed congregation who gather round the high priest Yakub in the synagogue at Nablus. The traveler who visits these lost remnants of the seed of Israel may carry his thoughts far back beyond the days of the Captivity, into the azure of the past, to the days when the ancestors of these men made the courts of Bit-Parra echo with hymns of praise to the Sun, the "lord of light and golden rays." The above is the record of an explorer's short campaign amid the buried cities of Chaldea, and its results are such as lead us to hope for richer discoveries in the future from the land where center all the traditions of the history and religion of Western Asia.

PREVENTION OF THE SPREAD OF SMALLPOX.—Dr. G. F. Pritchard, of Sittingbourne, in a note to the *Lancet* (July 9, 1881), mentions a very simple means of preventing the spread of smallpox by infection. He paints the whole surface of the body with a solution composed of gelatine and glycerine dissolved in a dilute solution of permanganate of potassium, which not only disinfects the skin but allays the intolerable irritation. In none of forty-eight reported cases which have come under his care did the disease spread.

GEOLOGICAL FACTS RECENTLY OBSERVED IN MONTANA, IDAHO, UTAH, AND COLORADO.

AT a recent meeting of the New York Academy of Sciences, Dr. J. S. Newberry, the President, made the following interesting observations:

Idaho and Montana.—The famous placers at Helena and Virginia, which have yielded thirty millions of dollars, are now exhausted, but vein-mining is in successful progress and yielding rich results at Butte, at the Alice, Lexington, Copper Bell, and other mines. These are true fissure veins, traversing a granite formation, and the speaker predicted their abundant yield of silver and copper twenty years hence. These territories have been simply crossed by two government expeditions, and their resources have not been at all studied. It is the coming mining region, more discoveries of promising mines having been recently made here than in any other portion of the country. On the east of the mountains in Montana and Wyoming lies a fine agricultural country and excellent stock range, the herds ranging freely throughout the winters, in spite of their severity, with little loss, and grazing upon a native bunch-grass (*Festuca scabrella*) and the buffalo grass (*Buchloe dactyloides*). The climate is salubrious, the country very beautiful in many parts, and very promising for emigration. In the adjacent Rocky Mountain range there are also many mining opportunities.

The remarkable lava plain, 400 miles long by 75 miles wide, in Central Idaho, was then described.

Snake River, one of the chief tributaries of the Columbia, flows along its southern border for several hundred miles, its northern tributaries sinking under the lava sheet and flowing in subterranean channels fifty or sixty miles long. The rock is a basalt, said to contain everywhere a small quantity of gold and silver. It is generally covered with an impalpable soil that produces a dust excessively annoying to the traveler, and sustains a general growth of sage brush. In places, however, the rock is bare and looks like a congealed stormy sea.

Three buttes are set on the surface of this lava plain, and each has probably been a local volcanic vent; but it is probable that most of this eruptive material has been an overflow from great fissures of which the position is not indicated on the surface.

Snake River crosses a portion of this plain in a cañon at the head of which are the great Shoshone Falls, 208 feet in vertical altitude.

An alluvial plain borders Snake River for 200 miles, abounding in black sand which contains much gold. This is, however, extremely fine, having been transported a long distance from its place of origin, and therefore difficult of separation. New and promising methods and machines are about to be tried in the exploration of these extensive deposits. A wide mountain belt extends from the north side of the lava plain to and beyond the British line, and is apparently a good mining country throughout. Already a great number of productive and promising mines are opened in the southern portion of this belt. In the Wood River district the veins are not large, but numerous, regular, and persistent, and the ore of high grade—mostly argentiferous galena, carrying $100 to $500 in silver to the ton. Near Challis, further north, is the celebrated Ram's Horn mine, located on a true fissure vein, generally not more than five feet wide, but continuous for more than five miles. The wall rocks are slate, the vein stone siderite (carbonate of iron), the ore gray and yellow copper, yielding $100 to $1,200 in silver to the ton. A few miles west of Challis is the mining town of Bonanza, where are located the celebrated Charles Dickens and Custer mines, carrying both silver and gold. Still further west, in the Saw-Tooth range, a high and very picturesque mountain chain running north and south, recent discoveries of valuable mines have been made. From this district north to the Canadian line, a broad mountain belt extends over Northern Idaho and Northwestern Montana a country which abounds in veins of silver, copper, and gold. Among the mines now worked in this region the most celebrated is the Drum Lomond, in Montana. It is opened on a large vein of rich quartz, and is owned by an old miner who cannot read, but who is said to have refused a million dollars for the property. It is probably worth much more than this.

Most of the mountainous districts of Idaho and Montana are covered with coniferous forests, consisting of the Douglas spruce and the northern nut pine, *Pinus flexilis*. The smaller plants form an Alpine flora of much interest, including many beautiful flowering species, perhaps the most striking being *Bryanthus*, which has a fine fir-like foliage and clusters of beautiful purple flowers. It belongs to the heath family, and closely resembles the heather of Scotland

The streams of this region are clear, cold, and rapid, and abound in fish, chiefly of the salmon family, and those have given the name to Salmon River, the principal water course.

Two species of salmon were running up the Salmon River: one the large Quinnat or Chinook salmon, comparatively rare, and the other the "red fish" (*Oncorhynchus nerka*). This is a small salmon, 15 to 18 inches in length, and weighing 3 to 5 pounds. As seen in their migration their bodies are brick red to purple in color, the heads dark or light green; they were then going up to their spawning ground, Redfish Lake, one of a half dozen of small lakes on the head waters of Columbia, which are the special breeding places of this interesting fish. Coming all the way from their abode in ocean, led by an infallible but inscrutable instinct, they push on night and day till they reach their remote birthplaces in these little lakes far up in the mountains and 1,000 miles from their starting point. Here they accomplish apparently the great object of their lives, the reproduction of the species, by depositing the spawn in the shallows of the rivulets which fall into the lake.

The always attractive coloring of the fish, during this nuptial season, becomes greatly heightened; the body assumes a brilliant, almost luminous red, as bright as that of the gold fish, and where numbers are dashing through the water literally in a blaze of excitement, they produce an exhibition that is strikingly novel and interesting.

When the spawning season is over they probably do not return, as none are seen descending the rivers. The young fish start on their migration to the ocean while yet very small, and within the first year of their lives, remaining away, it is supposed, some three or four years, during which they acquire their full growth, when they return to die where they were born.

An active industry has grown up in the capture of the red fish in their annual migrations, but it is pushed with so much energy and unsparing cupidity that their numbers are rapidly diminishing and the species will apparently be soon extirpated in these waters unless protected by legal enactment.

A branch of the Union Pacific Railroad is being construc-

ed from Granger, Wyoming, to the mouth of the Columbia. On this a large amount of traffic is expected, as it will link together many settlements having a considerable resident population and traverse in different portions of the route rich agricultural and mining districts.

Dr. Newberry then briefly described a small but remarkably rich placer gold deposit he visited on the west flank of Mount Wheeler, the highest mountain in Nevada, and mentioned the discovery of an outcrop of lower silurian rocks, full of fossils, including several new trilobites discovered by him in Southwestern Utah, but deferred all details till he should make them the subjects of special remark to the Academy.

Colorado.—Reference was made to the general character of Southwestern Colorado, the interesting topography of the region, especially the vast plateau which rises westward from the base of the Rocky Mountains on to the slopes of the Wasatch; the ascent of Marshall's Pass by the Denver and Rio Grande Railroad, the most remarkable feat of railroad engineering performed in the country, and the exceedingly picturesque region about the Pagosa, the greatest hot spring on the continent. Where the San Juan river issues from the mountains a prairie occurs, surrounded by picturesque forest-clad hills, and with a beautiful view of snow-clad mountains in the distance. In the center of the prairie lies a basin 40 by 60 feet across, boiling like a huge caldron, the ebullition being produced by the violent escape of carbonic acid gas. The banks are lined by the remains of beetles, snakes, etc., destroyed by too trustful reliance upon the hot waters, and by interesting mineral deposits. This is one of the most beautiful places in the country and likely to be a famous resort.

Along the route from Pueblo to Gunnison and Lake City, and thence eastward by Del Norte, there are some places of resort for invalids and pleasure-seekers, which are destined to be very well known, being far more beautiful and salubrious than the now celebrated localities at Manitou and Colorado Springs. One of these is Wagon Wheel Gap, on the Rio Grande. The river is a rapid, turbulent stream, and the Gap is seven to ten miles long, just wide enough to permit a wagon-road. Then a wide open space is reached, the basin of an ancient lake, girded by a wonderfully beautiful amphitheater of mountains. Here, 8,500 feet above the sea, the hot springs, charming rides, fine hunting and fishing, an atmosphere as pure and clear as crystal, constitute the attractions of a resort, which far surpasses any other, and which will be reached by the railroad now being pushed through the Gap about January 1, 1882.

From Gunnison, specimens have been recently brought of magnetite and hematite, which probably represent inexhaustible masses, and at Crested Butte, within twenty-five miles of this locality, is found the best coking coal in the West. The region borders on a volcanic area, and the coking coal is from that portion of the basin which has mostly escaped the alteration by volcanic heat. It is firm and not affected by the weather, with a small amount of ash and sulphur.

On Anthracite Creek are found many thousand acres of Anthracite of better quality than that of Pennsylvania.

Recent analysis made at the School of Mines shows it to contain less than one per cent. of sulphur, and three per cent. of ash.

The forest vegetation of Colorado is very simple. The piñon or nut pine is very common, also the yellow pine (*P. ponderosa*), Douglas' spruce, Menzies' spruce, etc. In the mountains the general vegetation is picturesque, but not so varied as in the lowlands. The following plants are among the most characteristic in the lowlands of Colorado and Utah.

The evening primrose (*Œnothera cæspitosa*), with its large beautiful white flowers.

The wild tobacco (*Nicotiana attenuata*).

The sun flower (*Helianthus*).

The bee flower (*Cleome integrifolia*), presenting purple acres by the roadside, and the yellow species (*C. lutea*), less common.

The American primrose (*Primula parryi*).

The pasque flower (*Anemone patens, Var. nuttalliana*).

The *Eriogonums*, about twenty species, coloring whole mountain sides yellow.

The Oregon grape (*Berberis aquifolium*).

Phacelia circinata in tufts of purple flowers on rocky slopes.

The lily (*Calochortus gunnisoni* and *C. nuttalli*) or "black-eyed Susan" (Indian—"Seego"), very plenty in the moister portion of the sage-plains.

The clematis (*Anemone alpina*), with its purple flowers.

The penstemons, of which 20 or 30 species are peculiar to that country, deep crimson, pink, and purple, and blue in color, often very showy, and so abundant that whole acres of ground are colored by them.

The columbine (*Aquilegia canadensis*), and also a much larger species (*A. cerulea*), clothing the mountains of Colorado and Utah with blue, cream-colored, and white flowers. A large number of dried plants were exhibited from a collection of several hundred species just brought on from Colorado, with collections procured from Prof. Marcus Jones, of Salt Lake City, and others.

ON THE GEOLOGY OF "THE PALISADES."

By ALBERT E. HOPPOCK, Hastings on the Hudson, N. Y.

IN the estimation of geological time, it is customary to divide the different ages of the earth's history into periods and epochs, which are classified in accordance with the organic remains which are therein found.

Beginning first with the oldest rocks, those which were formed before animal or even vegetable life was a possibility. This is called the Azoic, or lifeless age, and is the foundation on which, so to speak, the rocks of the successive ages have been deposited.

Next in our time scale comes the Paleozoic Age, or the age of the dawn of life; that age during which animal and vegetable matter in its simplest forms appeared.

This age comprises three grand divisions or periods: First, the Silurian period, or the Age of Mollusks; second, the Devonian period, or the Age of Fishes; third, the Carboniferous period, or the Age of the Coal Plants.

Leaving the Paleozoic, we arrive at the Mesozoic Age, or the Age of Reptiles. This age is also divided into three grand divisions or periods: First, the Triassic; second, the Jurassic; third, the Cretaceous.

We next arrive at the Cenozoic Age, or the Age of Mammals. This age is divided into two periods: First, the Tertiary; and second, the Post Tertiary. And finally we arrive at the Age of Man, or, we may say, the Historic Age.

Such, then, is a brief review of the grand divisions of geological time.

The range of hills of which the Palisades form a part extend for a distance of about 48 miles, 28 of which are in the State of New Jersey and 20 in the State of New York.

Professor Dana states that they are simply the northern extension of a very long range, extending through New Jersey and Pennsylvania into Virginia, and following the course of the Triassico-Jurassic sandstone areas.*

The Palisades proper begin in the township of North Bergen, N. J., where they strike the line of the Hudson River above Weehawken. From Fort Lee, N. J., north to Sneden's Landing, N. Y., they present a very bold and imposing front, rugged and columnar in appearance, well meriting the name, "the Palisades."

They vary in height from 350 to near 500 feet. Opposite Hastings they attain height of 489 feet, which is the highest point of the Palisades proper. The highest point in the range is just south of Haverstraw, the mountain called "High Tom," which reaches an elevation of 1,010 feet above the level of the river.†

The general direction of the range is in the form of a bended bow, following the bend of the river, and at the northern and southern extremities trending inward.

At the base of the cliffs on the line of the river vast masses of *débris* have accumulated, in many cases extending almost to the top. This permits of the construction of paths to the summit, especially where valleys have been worn through the range by the action of water.

This will probably suffice for a geographical description of our subject, and we will now pass to the geological description, one which is not capable of such an easy or satisfactory disposal.

It was probably during the earlier epochs of the Triassic period of the Mesozoic Age that the Palisades were formed, during or immediately subsequent to the Jurassic epoch in the Sandstone, or Bunter sandstein of the Germans.

This fact may be clearly shown on examination, as the rocks will be found to rest upon beds of this formation, and again, in other localities, both to rest upon and be covered by the layers of sandstone.

This fact is not easily determined on account of the masses of *débris* accumulated at the base of the cliffs; still, there are places where the rocks have been laid bare, either by natural causes or artificial means, which will fully establish this fact.

Before proceeding further, let us see to what conclusions this fact should lead us, and there are here only two which present themselves for consideration: First, that they are contemporaneous with the beds of sandstone, or, second, that they are of later formation.

In order that they may be contemporaneous it is necessary that they should be of a somewhat similar character and composition to the beds between which they rest.

Now, the rocks which cover, and upon which the Palisades rest, are found upon inspection to be sandstone, and it is well known that sandstones are what are called sedimentary rocks, or rocks which are formed by the deposition from water of the disintegrated portions of other and older rocks; therefore a comparative examination of the rocks will dispose of our first, and lead also to a solution of our second consideration.

We find that the rocks of which the Palisades are formed are not sedimentary rocks; nor do they in any manner approach in composition the sandstones between which they rest.

They are trap-rock, or rocks of an igneous origin, and are simply vast masses of erupted rock.

Owing to extensive depressions of surface, cracks or fissures were produced in the sandstone, through which masses of the highly heated rock oozed out, became solidified, and remained in its present location between the layers of sandstone.

During the subsequent Jurassic epoch, that epoch characterized by those enormous convulsions of the earth's surface so plainly shown in the Jura, from whence the name, the sandstone beds and the inclosed trap became so tilted that finally the range was left in its present position.

The subsequent action of water and other agents has worn away the comparatively soft sandstone, leaving the hard and durable trap exposed.

A close examination of the layers of sandstone where they border on the trap shows them to be partially melted, as it were, by its proximity to some highly heated mass. Masses of scoriæ are also found embedded in it, and also great holes and bubbles blown as if by the escaping steam.

This, therefore, while negativing our first conclusion, gives the affirmative to our second.

Trap-rock shows throughout a crystalline structure, breaking equally well in all directions, which makes it a valuable rock for paving purposes.

It consists principally of feldspar and hornblende, and in its chemical composition much resembles dolerite.

The following analysis is a fair representation of the composition of trap from this range:

Specific gravity	2·96
Silicic oxide	53·16
Alumina	13·87
Ferric oxide	9·09
Manganic oxide	0·44
Lime	9·44
Magnesia	8·56
Soda	2·28
Potassa	1·03
Loss on ignition	0·89

The principal minerals found associated with the trap are pyroxene, labradorite, magnetite, and often traces of cryolite and apatite. The pyroxene belongs to the ordinary variety, augite, as noted by G. W. Hawes in the Connecticut trap-rocks, which belong to the same epoch and are almost identical in character and composition.

A peculiar characteristic of the trap ranges in this vicinity is their curved form, which is plainly shown in the range under consideration, but much more prominently in the ranges which exist in Connecticut.

* *Am. Jour. Sci.*, 3-6-106.

† "Natural History of New York." Geology, First District.

BLACK ANTS A CURE FOR CURRANT WORMS.—A correspondent of the *Ohio Farmer* finds the common black ant an efficient protection against the plague of currant worms. He has several colonies of ants close to his currant bushes, and enjoys an abundance of currants, while his neighbors' bushes are overrun with worms. Formerly he took pains to distroy the ant colonies, but on witnessing their attacks upon the worms he has taken pains to protect and encourage them.

NIAGARA RIVER.*

ITS CAÑON, ITS DEPTHS, AND ITS WEAR.

FOR several years a committee has been continued by the American Association for the Advancement of Science, for the purpose of memorializing the Legislature of the State of New York for a new survey of the Niagara Falls. I am not aware just how long this committee has had an existence, or that it has done anything toward the end for which it was created. Its usefulness, however, closed some time in August, 1876. It was during that season that the United States Lake Survey appeared at the mouth of the Niagara River, and within three months every iota of attainable information was added to knowledge. Strange to say, none of the data secured found its way into a government report, and only an outline chart was placed on record to mark some of the work done. Very few of the results have been published. Some of the facts appeared in the Suspension Bridge *Journal* and the Syracuse (N. Y.) *Daily Standard*, from my pen; but this paper will contain the first reliable scientific sketch of the river, its cañon, depths, and wear, resulting from that survey.

HYDROGRAPHIC WORK.

Many attempts were made previous to the government survey to obtain the depths of the water in the cañon below the Falls. Bars of railway iron, pails of stones, and all unreasonable and awkward instruments were attached to long lines and lowered from the railway suspension bridge, but positively refused to sink. The reason for this is obvious. The very bulk of the instruments was sufficient, no matter what their weight, to give the powerful undercurrent the means to buoy them upon or near the surface. Our party, however, with a small sounding lead of twelve pounds weight, attached to a slender cord, easily obtained the depths from the Falls to the railway suspension bridge. One day we launched a small boat at the inclined railway, and entered on a most exciting and perilous exploration of this part of the cañon. The old guide long in charge of the miniature ferry situated here accompanied the party. With great difficulty we approached within a short distance of the American Falls, which darted great jets of water upon us and far out into the stream. The roar was so terrible that no voice or human sound, however near we were to one another, could be heard. The leadsman cast the line, which passed rapidly down and told off eighty-three feet. This was quite near the shore. Passing out of the friendly eddy which had assisted us so near the Falls we shot rapidly down the stream. The next cast of the lead read one hundred feet, deepening to one hundred and ninety-three feet at the inclined railway. The average depth to the Swift Drift, where the river suddenly becomes narrow, with a velocity too great to be measured, was one hundred and fifty-three feet. Just under the railway bridge the whirlpool rapids set in, and so violently are the waters agitated that they rise like ocean billows to the height of twenty feet. At this point I computed the depth at two hundred and ten feet, which was accepted as approximately correct.

CAÑON NOTES.

The geological formation of Niagara's cañon is too well understood to bear comment. Some of the topographical appearances, however, may be mentioned. The cañon's walls range from two hundred and seventy to three hundred and sixty feet in height above the water level. Of course, they are highest at their termination at Lewiston, where, on the opposite side, the base of Brock's Monument is three hundred and sixty feet above water in the cañon. The walls are continually crumbling owing to the action of the atmosphere, frost, and miniature springs. The *débris* is driven out into Lake Ontario, forming what are known as the Brickbat Shoals, situated three and a half miles from the river's mouth. The river within the walls, more especially where the cañon is narrow, is subject to rise and fall at short intervals, if the wind is heavy on Lake Erie.

A party of four, including the writer, made a survey of the interior of the cañon from Lewiston to the Suspension Bridge. The perils of such a passage are known to but few, and can only be realized by the daring adventurer who may undertake it for himself. Indeed, the foot of man scarcely ever treads this infernal region, where on every hand one is beset by untold difficulties. With great caution we clambered along, making a fearful yet intensely exciting exploration. At times the river would rise suddenly some ten or fifteen feet, as if some dam above had broken, causing a hasty retreat up the cañon's sides. From points above loose fragments of rocks precipitated themselves, causing a lively scattering beneath. An occasional rattlesnake leaped from his den in astonishment at such intrusion, only to yield his life as a penalty. Here and there gigantic bowlders reared their heads from the water's edge, necessitating a difficult and dangerous passage around or over.

Once the writer saw a bird's nest on the extremity of an alder, which leaned well over the seething, whirling waters. Our approach caused a rare sparrow to flit away in alarm. Without thought, save of the acquisition of a rare egg, I threw by my coat and sprang into the branches. I had gone but half way out on the limb when a wild cry of alarm caused me to look around, just in time to see the roots of the little tree being wrenched from their place by my weight and the fierce current. I gave a spring and landed safely, just in the instant as the tree fell into the waters and was hurried out of sight.

Getting into the cañon at Lewiston was comparatively easy, but making one's way out near the Falls was another thing. Nearly a mile below Devaux College, situated a little north of the railway bridge, the possibility of making our way along the river's edge ceased. Night was approaching, and a day's hard work would be required to reach Lewiston, at the foot of the cañon, from which point we entered. Above, the rocks towered several hundred feet. We had the alternative of remaining in the gorge over night, where life was momentarily uncertain, or of fighting our way over an almost impassable passage to the foot of the steps leading down from the college. We determined to accept the latter. After an hour's climb over tangled masses of fallen trees, logs, and bowlders, we made our way to a narrow ridge, one hundred feet from the top, formed of fallen *débris*. The scene from this point beggared description. Beneath was one frightful mass of rocks and trees. One false step and the fated individual would have plunged to a horrible doom. We followed the ridge for perhaps a half mile, when it came to an abrupt termination. In front were bare walls of perpendicular rock, extending from the top one hundred feet above, straight down to the rushing waters two hundred feet below. The interim to be crossed, if possible, was several rods in

* A paper read before the American Association for the Advancement of Science, by Wm. Hosea Ballou, of Chicago, at the Cincinnati meeting.

breadth. Despair stalked abroad on every side. The setting sun cast his flickering rays upon an almost certain doom to the daring mortal who should attempt that passage. Just above our heads a crevice in the rocks was discovered which seemed to cross the face of the rocks. The thought of passing it was startling, but hurriedly agreed upon. There seemed to be room for the toes to cling, but the chances of a place for the hands seemed slender and treacherous.

The various instruments were divided among the party by lot, the box containing the heavy theodolite falling to the writer. The tallest clambered on to the crevice first, the others assisting and following, until the writer, smallest and last, was safely drawn up. A perilous and cautious passage began. The face of the rock was slippery, and the niches where the hand could cling few and far between. One carrying a coat on his arm, in a moment of trepidation let the garment fall, and in an instant it was whirled out of sight by the seething waters below. Another unloosed a bowlder, which took a frightful plunge downward, leaving a great open space beneath. By mutual assistance all had safely passed across, when the writer, with the heavy instrument upon his back, was midway on the passage. Here a sharp point of rock, just breast high, impeded the way. In attempting to get around this, the boat failed to find a resting place. To get under was impossible—above there was no fingerhold. The heavy instrument behind seemed to weigh down like a mountain, and was rapidly displacing the point of balance. The slender hold was relaxing; 100 feet above was the calm, safe world—250 below, the merciless waters. One foot slipped off, and was going down—down; a mist came over the eyes and all seemed lost, when the foot caught on a slender bush, a hand grasped the back and drew me on to a firm footing. Just then the sun sank from sight, but not until he saw the adventurers safe on the steps of the college. Once I stood on the narrow, swaying foot bridge midway between the towers of the East River structure, 278 feet above the dizzy masts below, alone with the Infinite, where one false step would have ground the flesh to atoms before it struck the water. For three whole days upon a time I was at the mercy of an ice-gorge on the Mississippi, only escaping an unknown death by springing from cake to cake and finally crossing a chute on a slender tree up to the nostrils beneath the muddy waters. Once I was driven six hours about Lake Erie by an equinoctial storm in a small boat, and cast upon the sands of an island drenched and exhausted. But all these reminiscences I count but pleasures, when the thought of the thrilling escape in the cañon of Niagara comes to mind.

THE WHIRLPOOL.

The most remarkable feature of the gorge is the Whirlpool, situated several miles below Suspension Bridge. Its surface covers an area of about a quarter of a mile square. Its depths are evidently great. Dead bodies which pass over the Falls usually require nine days to make their way through it and reappear on the surface. Marked logs have been tossed into it to be borne slowly down and to appear again at the end of the same period of time. One thing is evident, it has no underground outlet. There can be no such gigantic cause without an effect as great. The huge mouth receives nearly all the water that flows over the Falls. If there were an underground outlet, there would be at some other point of exit a mighty volume of upheaving waters. No spring has yet been found on earth so large as to throw up the quantity of water driven in at the Whirlpool. Where, then, does the water go? is the startling question which investigation readily answers. The position and form of the Whirlpool is circular. It was shown above that the average depth of water is one hundred and fifty-three feet. The mighty current is not confined on the average to the surface, one side, or the bottom of the cañon. The whole body of water moves, glacier-like, with one velocity more swift than can be conceived by man. It is like a solid body, one hundred and fifty-three feet high, nine hundred feet wide, and of infinite length, moving along at a wonderful rate of speed. The bulk of this body enters the Whirlpool on one side, where it moves round like a top, keeps the water circulating for an unknown depth, and finally passes out on the north side to rush madly on. It whirls around by its own velocity at the entrance, and needs no outlet to suck it down, being forced down and out by the tremendous pressure from above. The Whirlpool is undoubtedly of great depth, which would appal one as incredible should I express my opinion. Suffice it to say that, to make this excavation—and here is the secret of its origin—the Falls must have been at work there for thousands of years. Its existence is the most convincing proof of the many others, that the Falls hewed their way to their present position.

THE CAÑON'S WEAR.

Can the wear of the cañon be determined? It seems possible. In 1842, Prof. John Hall made a survey of the Falls and left stones used in triangulating, standing. The United States Corps of Engineers used exactly the same bench marks for the operations completed in 1876. After the most careful and exhaustive work with the best instruments no perceptible change could be detected. Lyell considered the retrocession of the Falls one foot per year—a most stupendous error. Suppose it be one-half inch per year—an amount too excessive by far—the fragments of rock thus displaced would, if compressed into one body, contain about 62,500 cubic feet. Let any one figure that desires. The approximate measurements make the Falls 5,000 feet long. The face of the rock is 300 feet high above and below water. Hence, 5,000 feet × 300 × ½ ÷ 1,728 = 62,500 cubic feet.

There are two fair deductions to be made from this formula. One is concerning the amount of time the river has been excavating its cañon, and the other as to when the Falls may be expected at Buffalo. The river distance from the Falls to the mouth of the cañon is about ten miles. If the maximum estimate of our engineers of half an inch per year is allowed, the Falls have been 1,267,200 years in reaching their present position. The river distance to Buffalo is 2½ times as long, an equivalent of 3,168,000 years. The bed of the river from the Falls to the outlet of Lake Erie was ascertained by thousands of soundings to be bed rock, so that a natural drainage of the great lakes by the Niagara River need not be anticipated as long as man may be permitted to exist.

THE FUTURE.

The bottom of the cañon is slowly wearing away. The time must come when the river at the foot of the Falls will be on a level with Lake Ontario.

MISTS.

The grandest view, of every shade of color included in the rainbow, may be seen by the morning's sun above the Falls. A number of trips were made across at the head of the Rapids as near the Falls as possible. Gigantic clouds of mists arose at the edge of the Cataract. In passing slowly over with the July sun several hours' high at our backs, every conceivable hue of the colors of the rainbow were examined in turn, at leisure, a sight which would dazzle an artist with a specimen of nature's painting hard to imitate.

RECENT EXTINCTION OF THE MASTODON.

THE existence of the mastodon in North America must have been more recent than commonly supposed. A number of new facts bearing on this subject are to be found in Professor John Collett's "Geological Report of Indiana for 1880," recently issued. Of the thirty individual specimens of the remains of the mastodon (*Mastodon giganteus*) found in Indiana, in almost every case a very considerable part of the skeleton of each animal proved to be in a greater or less state of decay. The remains have always been discovered in marshes, ponds, or other miry places, indicating at once the cause of the death of the animal and the reason of the preservation of the bones from decay. Spots of ground in this condition are found at the summit of the glacial drift or in "old beds" of rivers which have adopted a shorter route and lower level; consequently, their date does not reach beyond the most recent changes of the earth's surface. In fact, their existence was so late that the only query is, says Professor Collett: Why did they become extinct? A skeleton was discovered in excavating the bed of the canal a few miles north of Covington, Fountain county, in wet peat. The teeth are in good preservation, and Mr. Perrin Kent states that when the larger bones were cut open the marrow, still preserved, was utilized by the bog-cutters to "grease" their boots, and that pieces of sperm-like substance, two and a half inches to three inches in diameter (adipocere) occupied the place of the kidney fat of the monster. During the past summer of 1880 an almost complete skeleton of a mastodon was found six miles northwest from Hoopston, Iroquois county, Illinois, which goes far to settle definitely that it was not only a recent animal, but that it survived until the life and vegetation of to-day prevailed. The tusks formed each a full quarter of a circle, were nine feet long, twenty-two inches in circumference at the base, and in their water-soaked condition weighed one hundred and seventy-five pounds. The lower jaw was well preserved, with a full set of magnificent teeth, and is nearly three feet long. The teeth, as usual, were thickly enameled, and weighed each from four to five pounds. The leg-bones, when joined at the knee, made a total length of five and a half feet, indicating that the animal was not less than eleven feet high, and from fifteen to sixteen feet from brow to rump. On inspecting the remains closely, a mass of fibrous, bark-like material was found between the ribs, filling the place of the animal's stomach. When carefully separated, it proved to be a crushed mass of herbs and grasses, similar to those which still grow in the vicinity. In the same bed of miry clay a multitude of small fresh-water and land shells were observed and collected. These were: 1. Pisidium, closely resembling *P. abditum*, Haldeman; 2. *Valvata tricarinata*, Say; 3. Valvata, resembling *V. striata;* 4. *Planorbis parvus*, Say. These mollusks prevail all over the States of Illinois, Indiana, and parts of Michigan, and show conclusively that, however other conditions may differ, the animal and vegetable life, and consequently climate, are the same now as when this mastodon sank in his grave of mire and clay.—*Amer. Naturalist.*

FUR-BEARING ANIMALS OF MAINE.

THE value of the fur business done in the State of Maine annually exceeds $100,000. The largest individual dealer is a man in Brewer, who handles $35,000 worth per year. The number of fur-buyers in the State is not large. Their chief sources of supply are in the regions at the headwaters of the Androscoggin, Kennebec, and Penobscot Rivers, and the streams entering into them. Sportsmen and occasional hunters furnish a few pelts, but the bulk of the furs is furnished by the professional trappers. There are many hundreds of men in Maine who earn their living and support their families by hunting, trapping, and fishing, and who do nothing else except, perhaps, act as guide for pleasure-seekers in the summer months, for the whole year. They are just about starting now, and will remain till the latter part of November. Every year the fur catch decreases, and the bounds of the trapping lines are gradually becoming more limited. While game of most kinds is retreating further into the forest and becoming scarce, it is said that the number of moose and deer, which are protected by law, is increasing. In numbers the muskrat exceeds any other kind of game trapped for its fur in Maine and handled in Lewiston. They are caught in common rat traps, and fifty of these small traps are sometimes set by one trapper. Immense quantities of them are caught. Eight or ten thousand of them are shipped from Lewiston annually. Most of them are exported to Germany and Italy, where the skins are dyed and furnish a popular fur for linings and ladies' apparel. They are among the cheapest of furs. A very large quantity of skunk fur is also shipped from this city. It is used for trimmings in this country, and is often passed off for Alaska sable. The larger part of the skunk catch probably goes to France and Germany. The otter is one of the most valuable and rare fur-bearing animals trapped in Maine. Not more than 1,000 otters are annually caught in the whole State. The skins make a beautiful and warm fur, which is highly valued by the Russians, Greeks, and Chinese. The fur is a dark, glossy brown, and two kinds, one being soft, short, and thick, and the other longer and coarser and intermixed with the former. The value of a dressed skin runs from $10 to $18. Many of the otter skins caught in this State are sent almost around the world in the course of trade before reaching the place where they are finally worn. They are sometimes sent from Lewiston to New York, thence to London, to Leipsic, Moscow, Nijni Novgorod, and finally to a destination in China, where they will warm some high and mighty mandarin. A large number of "fishers" are trapped in Maine, and a good many sables annually find their way to this market. The value of our sable or beech marten is much less than that of the Russian sable, which is the most costly of all furs. It is a small animal, about three times as large as the common weasel. Only about 25,000 are annually taken. These small skins sell at $25 to $200 each. The chief demand is in Russia, where the use of the sable is monopolized by the royal family. The fur of the fisher (an animal resembling the fox) is rich and soft and dark brown in color. It is very little used in this country, but goes chiefly to Poland, Germany, and Russia. The annual sales of red fox furs in Lewiston are very large. Most of them are exported. The Russians use the red backs, and the Greeks use the bellies, which are white. The fur of the bear, of which many are killed every year, is used both for robes and for military purposes. Thousands of beavers are killed on the streams flowing into our rivers every year. Their fur was formerly used largely in the manufacture of hats, and was the leading article in the fur trade; but its use for this purpose has been greatly diminished by the employment of silk and other less expensive materials. It makes handsome trimming, and fine collars and gloves for gentlemen. The lynx is an animal which frequently finds its way into the traps. The fur is soft, warm, and light, naturally grayish, with dark spots, but commonly dyed a beautiful black, and used largely for ladies' mourning attire. Minks are frequently found not far from home, and a great many come down from the Dead River. The mink was formerly a favorite fur in this country for muffs, collars, etc., and commanded a high price, but is going out of fashion. Rabbit and coney skins are used extensively by hatters and for trimmings. The coon skin is by no means a vulgar fur, and is not patronized solely by woodmen. Nearly all the raccoon furs are sent to Russia, where they are worn as coat linings by the Russian nobles. —*Lewiston Journal.*

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